



Town of Arlington
Department of Health and Human Services
Office of the Board of Health

27 Maple Street
Arlington, MA 02476

Tel: (781) 316-3170
Fax: (781) 316-3175

Artificial Turf Study Committee Agenda
01/09/24

Meeting Date: January 9, 2024

Meeting Time: 5PM-6:30PM

Location: Zoom

Objectives:

- 1) To review research findings and materials within each of the working groups.
- 2) To provide feedback/guidance to each working group on current research findings.
- 3) To further clarify additional research needs within working groups and any additional topic areas relevant to Artificial and Natural Turf fields.
- 4) To discuss additional research methods such as testimony/presentations from Subject Matter Experts.

Agenda

- I. Acceptance of Meeting Minutes
- II. Discussion: Committee Member update
- III. Correspondence Received
- IV. Working Group updates
 - a. Health
 - b. Safety
 - c. Environmental
- V. Discussion: Additional research needs/ gaps
- VI. Discussion: Subject Matter Experts
- VII. Discussion: Review 2024 Meeting Schedule
- VIII. New Business
- IX. Adjourn



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Artificial Turf Study Committee Meeting Minutes

Meeting Date: December 19, 2024

Meeting Time: 5PM-6:30PM

Location: Zoom- Registration link:

<https://town-arlington-ma-us.zoom.us/meeting/register/tZYsf-itpziG9GZInf8UKavOsUxoXrFG5ko>

Objectives:

- 1) To define specific topic areas to be studied/researched in each of the working groups.
- 2) To approve the topic areas to be studied/researched in each of the working groups.
- 3) To establish guidelines for the Committee to conduct and evaluate research.

Committee Members present: James Ditullio, Chair; Natasha Waden, Clerk; Mike Gildesgame; Leslie Mayer; Joseph Barr; Jill Krajewski; Marvin Lewiton; Joseph Connelly; David Morgan.

Agenda

I. Acceptance of Meeting Minutes

Motion made by Leslie Mayer to approve the meeting minutes from December 12, 2023.

2nd by Marvin Lewiton

Vote:

Mike Gildesgame, not present for vote
Leslie Mayer, Yes
Joseph Barr, Yes
Jill Krajewski, Yes
Natasha Waden, Yes
Marvin Lewiton, Yes
James Ditulio, Yes

Approved (6-0 with 1 Absent)

II. Correspondence Received

Natasha Waden shared correspondence received from Joan Roman, Town of Arlington Public Information Officer, as it pertains to the recording and posting of meetings. Waden informed the Committee that it is possible for the Town to record the Artificial Turf Study Committee meetings, but posting on the website is a bit more complicated. As such, it has

been common among other committees/boards that record meetings to have Arlington Community Media Inc. (ACMI) post the recordings and for the Town to provide a link to the recording on the appropriate website. The Committee agreed this would be appropriate moving forward. Waden informed the Committee that the deadline to include correspondence for today's meeting was last Thursday at 5pm, so any correspondence received after that would be included in the next meeting. The Committee acknowledged correspondence received, but there was no further discussion on it. Jim Ditullio shared that the Chat function during the meeting has been helpful and it will continue to be available to the public.

III. Working Group updates

a. Health:

This working group is comprised of Natasha Waden, Marvin Lewiton, and Jill Krajewski. The group met on Saturday 12/16/23 and discussed the need to research the following topic areas: chemicals associated with turf (including PFAS, PFOS, VOC's, Semi Voc's, PAH's); mold; bacteria; metals; heat related illness; factors that contribute to overall physical and mental health; and exposure risks. The group plans to research these topics and make a comparison between artificial turf and natural turf. Additionally, a request was made to the Department of Public Works to inquire about field maintenance schedules and/or any products that might be used on fields as part of treatment/care/maintenance.

b. Safety:

This working group is comprised of Jim Ditullio, Joe Connelly, and Leslie Mayer. The group met earlier today and identified two primary focal areas: 1) Bodily injuries including but not limited to: concussions, skin abrasions, muscle/ligament tears; and 2) Heat Effects on living organisms. The group plans to research these topics and make comparisons between artificial turf and natural turf fields. The group also discussed the need for research to include evidence based and peer reviewed research articles. Additionally, a request was made to the Athletic Directors at both Arlington High School and Arlington Catholic High School to provide the group with any injury reports that have been reported internally or with the Massachusetts Interscholastic Athletic Association (MIAA). The group was also looking into Safety Data. A brief discussion was had about the difference in material between new and older fields as well as the maintenance needs.

c. Environmental:

This working group is comprised of Mike Gildesgame, David Morgan, and Joseph Barr. The group communicated through email and was able to identify the following topic areas to be studied: 1) Evaluating the onsite effect of the materials that make up the grass, infill and other components related to Artificial Turf; 2) Evaluating the run off effects/potential damage caused by components identified in Artificial Turf and the

effects it has on the environment including human life, aquatic life, and wildlife; 3) Heat effects on the environment, wildlife, and other things that come in contact with Artificial Turf; 4) Climate change resilience such as the temperature difference between Artificial Turf and Natural Turf and the impact of those changes and variations; 5) Soil Health and Biodiversity. The group stressed the importance of reviewing reference materials that are peer reviewed and science based. The group also mentioned that one of their members will be taking parental leave in the near future so it will be important to discuss how this working group will continue.

IV. Discussion: Agreement of Topic Areas in Working Groups

The Committee agreed that the working groups are off to a great start and should continue on with conducting research. There was general consensus that the Committee would not meet again until January 9, 2024 at 5PM via zoom, but in the meantime Committee Members would continue researching their topic areas and the working groups would meet during the first week of January. The goal is to have a more in depth update on the research efforts by each working group at the January 9th meeting.

The Committee discussed the feasibility of including in person testimony as part of the research. The Committee agreed that recommendations will come from the working groups and be presented to the larger group for consideration. As such, it was recommended that working groups begin thinking about this sooner rather than later. If the Committee decides to consider in person testimony, it would need to take place in the first couple of weeks in February.

The Committee also discussed research associated with crumb rubber infill and acknowledged that while this topic does need to be explored, there seems to be an understanding amongst the Members that crumb rubber is not the ideal infill for Artificial Turf. As such, the Committee agreed that crumb rubber will be researched but more attention would be focused on researching alternative components to crumb rubber infill. The Committee also acknowledged that by limiting the research on crumb rubber infill it is not the Committee's intention to overlook the other materials (backing, blades of grass, etc) and the respective chemicals/components that make up Artificial Turf.

V. Discussion: Guidelines for Conducting Research

The general consensus of the Committee was that research material should include a variety of aspects, including but not limited to the following criteria: peer reviewed; studied by academia and/or government agencies; and/or material published in a professional/reputable journal.

The Committee agreed that it is important to look into the author(s), such as their credentials, affiliations (including employment status), as well as the funding source of the research/study.

The Committee acknowledged that research takes a long time and in some cases relies on funding cycles. As such, the amount of material and/or availability of recent research

associated with Artificial Turf Fields may be limited. Therefore, the Committee determined they would not pose any time restrictions on research material.

VI. New Business

The Committee had no new business to discuss.

Natasha Waden reminded the Committee and Public that the cut off to include materials or correspondence received for a meeting is at 5pm the Thursday before a Tuesday Meeting (with the exception of a Monday holiday). Materials or correspondence received after that time will be included in the next meeting packet.

VII. Adjourn

Motion made by Mike Gildesgame to adjourn the meeting.

2nd by Marvin Lewiton

Vote:

Mike Gildesgame, Yes

Leslie Mayer, Yes

Joseph Barr, Yes

Jill Krajewski, Yes

Natasha Waden, Yes

Marvin Lewiton, Yes

James Ditulio, Yes


Approved (7-0)

Re: Artificial Turf Study Committee Meeting

Joe Connelly <jconnelly@town.arlington.ma.us>

Tue 12/12/2023 10:14 AM

To: Natasha Waden <nwaden@town.arlington.ma.us>; Mike Gildesgame <mikeg125@gmail.com>; Leslie Mayer <lmayer@town.arlington.ma.us>; jobar@alum.mit.edu <jobar@alum.mit.edu>; JILL.KRAJEWSKI.ARLINGTON@GMAIL.COM <JILL.KRAJEWSKI.ARLINGTON@GMAIL.COM>; Marvin Lewiton <mlewiton@verizon.net>; james_ditullio@hotmail.com <james_ditullio@hotmail.com>; David Morgan <dmorgan@town.arlington.ma.us>; Christine Bongiorno <CBongiorno@town.arlington.ma.us>; Jim Feeney <jfeeney@town.arlington.ma.us>; Colleen Leger <cleger@town.arlington.ma.us>

 4 attachments (15 MB)

Artificial Turf_ Health, Safety, and Environmental Considerations Copy.pdf; Grundstein 2020_Wet Bulb temps_sports fields & tennis court Copy.pdf; LincolnTurf_Turf_Presentation-FINAL-2-reduced_202303031621126219 Copy.pdf; PFAS Primer Copy.pdf;

Hi Everyone,

Attached is some data that you may find helpful. Two of the documents are from Weston Sampson and Activitas who did research for projects in Lexington and Lincoln. I also attached the slide deck from our Turf Forum which gives information from both sides of the turf discussion. Lastly attached is a scientific study on the heat concerns of turf.

Like I said in the meeting I am sure David can send you equally as many studies that show opposing results. What I came to find out is that "the science" is not really black and white, it is all how the data it is interpreted. I for one always thought the science was the science, I learned through this process that is not always the case.

Again, I think there are areas we can certainly agree on and that may be the easiest starting point.

Thanks,

Joseph Connelly, M.Ed.
Director of Recreation
Town of Arlington
781-316-3889
jconnelly@town.arlington.ma.us

Public Records Notice

Please be advised that pursuant to G.L. c. 4 sec. 7(26) email correspondence to and from public employees is considered a public record. Only where the content of an email falls within one of the stated exemptions within the law may the Town withhold documents or information.

From: Natasha Waden <nwaden@town.arlington.ma.us>

Sent: Friday, December 8, 2023 10:36 AM

To: Mike Gildesgame <mikeg125@gmail.com>; Leslie Mayer <lmayer@town.arlington.ma.us>; jobar@alum.mit.edu <jobar@alum.mit.edu>; JILL.KRAJEWSKI.ARLINGTON@GMAIL.COM <JILL.KRAJEWSKI.ARLINGTON@GMAIL.COM>; Marvin Lewiton <mlewiton@verizon.net>; james_ditullio@hotmail.com <james_ditullio@hotmail.com>; Joe Connelly <jconnelly@town.arlington.ma.us>;

David Morgan <dmorgan@town.arlington.ma.us>; Christine Bongiorno <CBongiorno@town.arlington.ma.us>; Jim Feeney <jfeeney@town.arlington.ma.us>; Colleen Leger <cleger@town.arlington.ma.us>

Subject: Artificial Turf Study Committee Meeting

When: Tuesday, December 12, 2023 5:00 PM-6:30 PM.

Where: Zoom

Please register in advance for this meeting:

<https://town-arlington-ma-us.zoom.us/meeting/register/tZwvd-6qrj0rH9OG2852OoCzLREcrdbX42VI>

After registering, you will receive a confirmation email containing information about joining the meeting.

Microsoft Teams meeting

Join on your computer, mobile app or room device

[Click here to join the meeting](#)

Meeting ID: 299 807 212 629

Passcode: VAFiwo

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Artificial Turf: Health, Safety, and Environmental Considerations

Panelists

Susan Chapnick, MS

President and Principal Scientist
New Environmental Solutions

Jeff Gentile

Co-Founder and Partner
Firefly Sports Testing

Laura Green, PhD, DABT

President and Senior Toxicologist
Green Toxicology LLC

Wendy Heiger-Bernays, PhD

Clinical Professor of Environmental Health
Boston University School of Public Health

Rachel Massey, ScD

Lowell Center for Sustainable Production
University of Massachusetts Lowell

David Nardone

Principal Owner and Landscape Architect
Vision Sports Design

Jay Peters

Principal Consultant, Risk Assessment
Haley & Aldrich

What is Artificial/ Synthetic Turf?

David Nardone

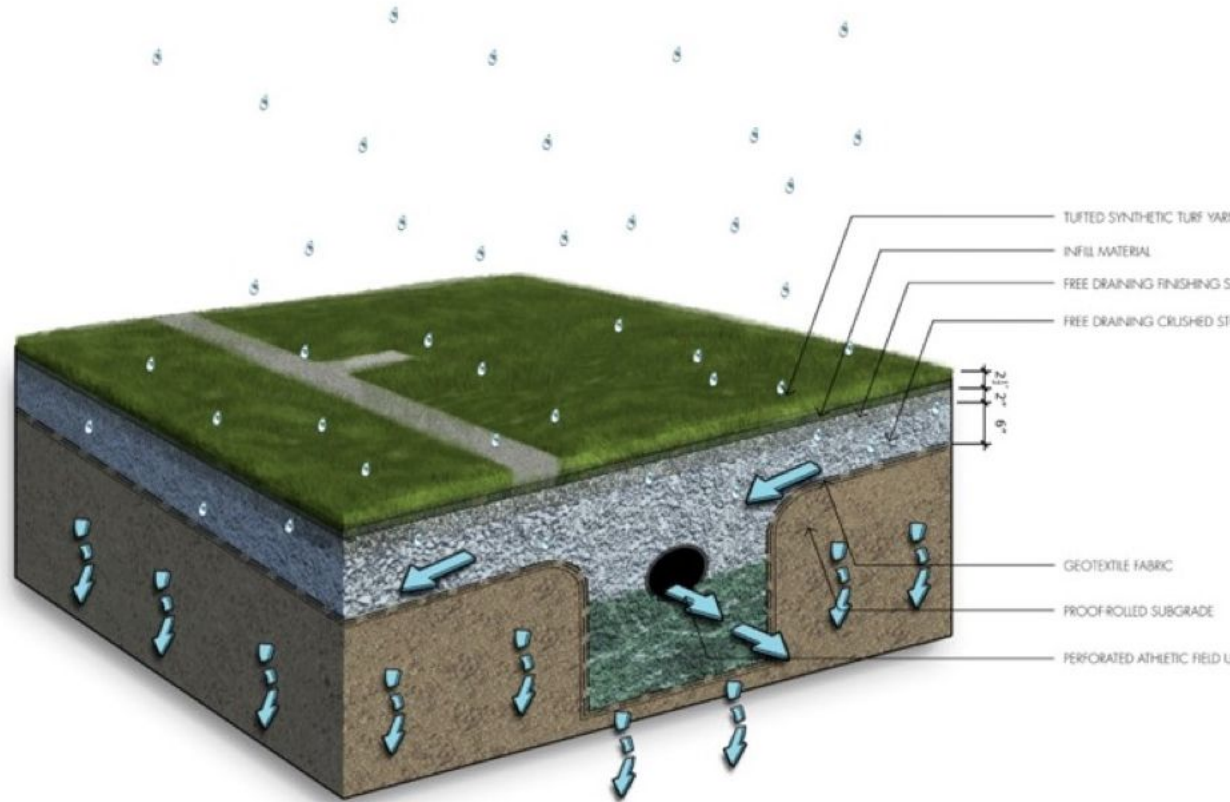
Synthetic Turf System

Infill

Turf 'Carpet'

Shock Pad

Drainage Base



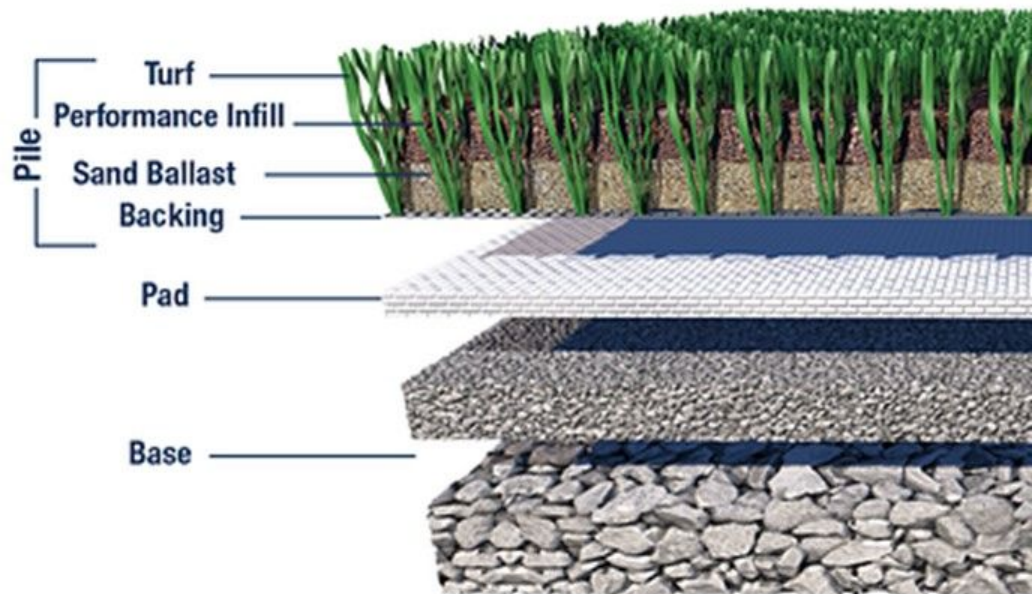
Synthetic Turf System

Turf 'Carpet'

Turf Fiber

Backing

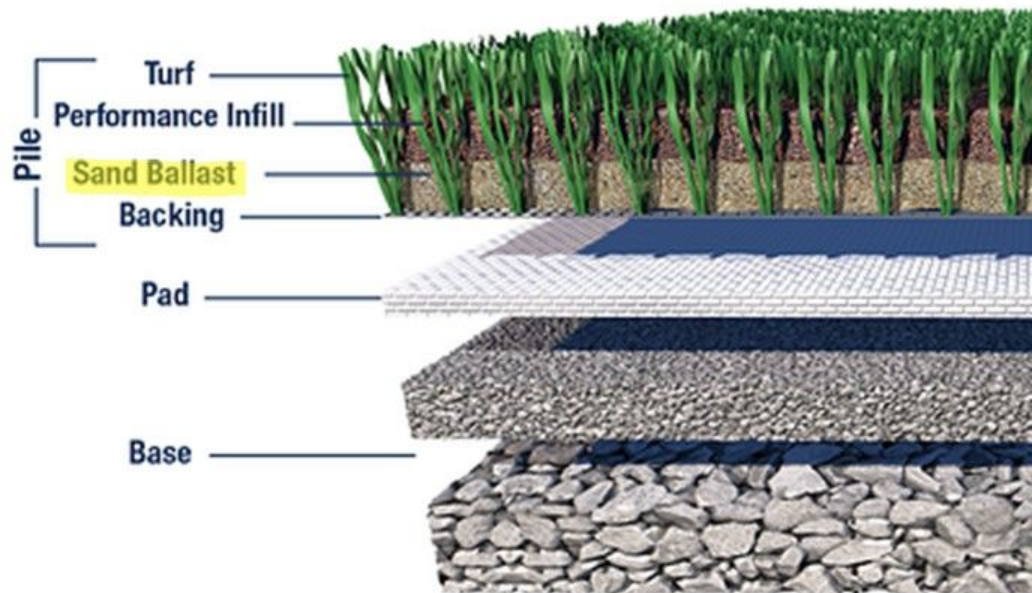
Secondary Backing



Synthetic Turf System

Infill

Sand



Synthetic Turf System

Infill – SBR

- Provides resiliency
- Recycled car tires



Synthetic Turf System

Infill – Virgin Rubber/Plastic

TPE (Thermoplastic Elastomer) or EPDM (Ethylene Propylene Diene Monomer (M-class) rubber)

- Provides resiliency



Synthetic Turf System

Infill – Natural Materials

- Cooler Surface
- Should be tested if source is unknown
- May require a little more maintenance



Synthetic Turf System

Shock Pad

Expanded PP

- Food Grade



Health and Safety Considerations

Conservation Commission

Dr. Wendy Heiger-Bernays , Dr. Rachel Massey



A Day in the Life: Home, School/Work, Car, + Turf

- Hazards, Exposure and Risk
 - Chemicals
 - Physical (Heat & Abrasive Surfaces)

What do we know, what is measured or modeled and what is uncertain?

Infills: Chemical Hazards

Tire Crumb: > 350 chemicals identified in EPA Tire Crumb Rubber Characterization

- Heavy metals (e.g. lead, zinc)
- Polyaromatic hydrocarbons (PAHs)
- Volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs, including PCBs)
- **Other chemicals**
 - Example: 6ppd-quinone from oxidized tire crumb rubber (Brinkmann, *et al.* 2022)

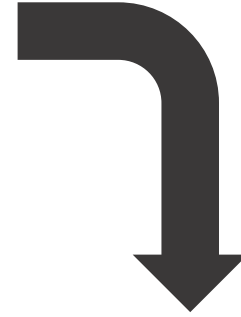
Other Infill materials

- Other rubber or plastic infills (Massey, *et al.* 2020)
- Plant-based or mineral-based infills

Lack of disclosure



Tire Crumb



Arlington Catholic Turf Field, 2021

Tires:

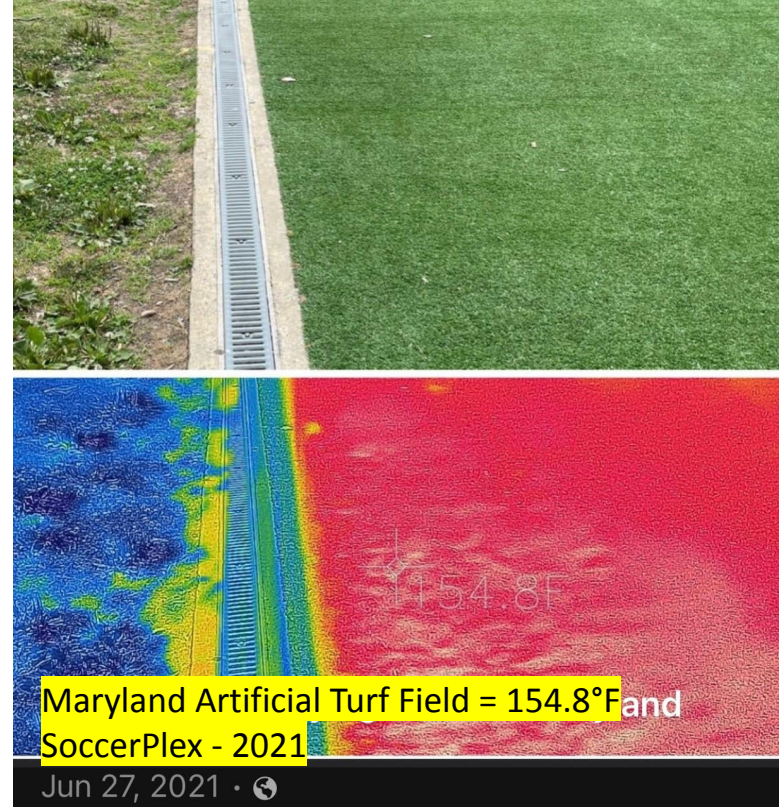
- Natural & synthetic rubber – fossil fuel sources
- Fillers
- Additional Chemicals = Antioxidants, antiozonants, vulcanization compounds

Infills, Blades, Pads and Backing

- Per- and polyfluoroalkyl substances (PFAS)
- Class of more than 12,000 chemicals - "forever chemicals"
 - Linked to health problems including cancer, immune dysfunction, thyroid, cardiovascular disease
- Communities & public interest researchers are investigating presence of PFAS in turf:
 - Testing turf samples
 - Testing environmental samples

Physical Hazards

- All artificial turf gets hotter than natural grass
 - Surface temperature of synthetic turf was 86.5° F hotter than natural turf and 37° F higher than asphalt
(Brigham Young Univ. Study 2019)
 - Maximum surface temperatures during hot, sunny conditions averaged from 140°F to 170° F
(Penn State Univ. Center for Sports Surface Research 2012)
- Choice of infill type may lead to some variation in the amount of excess heat
- Concerns: heat-related illnesses & burns



Risk of Heat Injury & Abrasions are Elevated on Artificial Turf

Safety Concerns

Examples of policies and guidelines for using artificial turf in the heat

Burlington, MA School District:

- NWS Heat Warning for a minimum of 2h = NO practice or play on an artificial turf or track surface during the full sun hours of 11 a.m. - 4 p.m.
- Practice or game play on a grass surface may be no more than 1h hour and no equipment is to be worn.
- If artificial turf surface temperature is above 121°F, activity must be moved to grass.



Many communities are recognizing & addressing the accumulating negative impacts of artificial turf

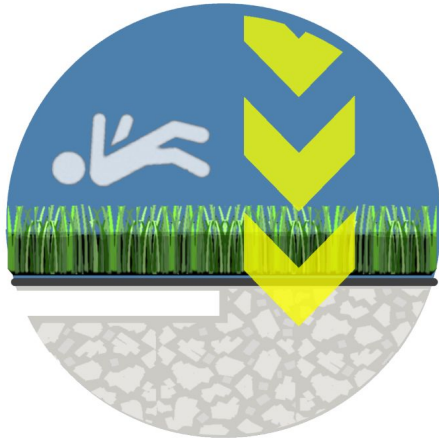
Parks & Recreation Commission

Jeff Gentile and Dr. Laura Green

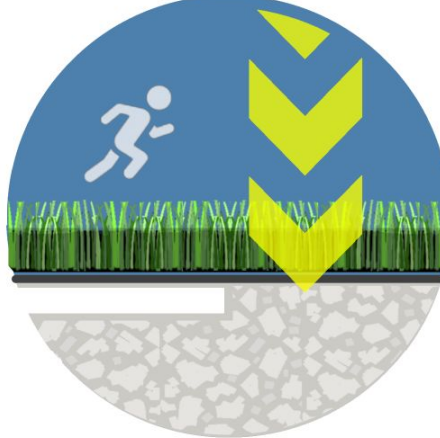
Basics of Field Performance Testing

What surface interactions are being evaluated?

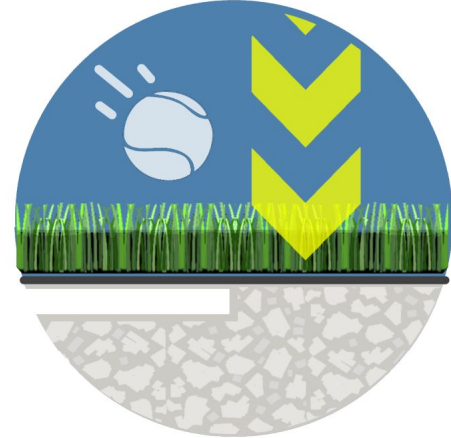
Head



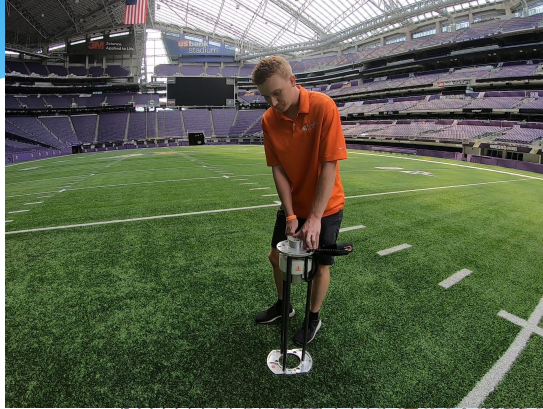
Underfoot



Ball



Head-Surface Interaction

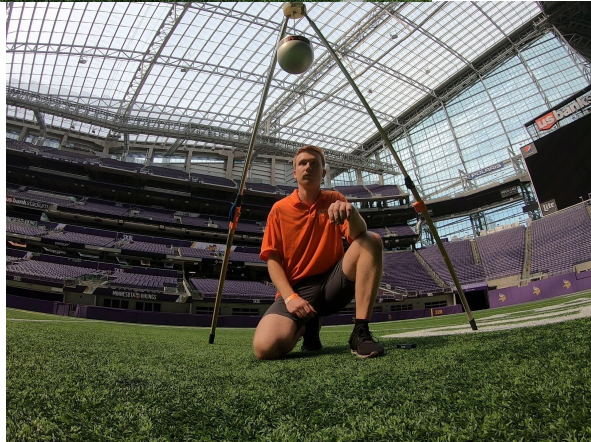


- **g-max Testing**

- **ASTM F1936-19** *Impact Attenuation of Turf Playing Systems as Measured in the Field*

- **HIC Testing**

- **ASTM F3146-18** *Standard Test Method for Impact Attenuation of Turf Playing Systems Designated for Rugby*
- **ASTM F1292-18** *Standard Specification for Impact Attenuation of Surfacing Materials Within the Use Zone of Playground Equipment*
- **EN 1177:2008** *Impact attenuating playground surfacing - Methods of test for determination of impact attenuation*
- **EN 1177:2018** *Impact attenuating playground surfacing - Methods of test for determination of impact attenuation*



Underfoot Interactions



Advanced Artificial Athlete (AAA)

- ASTM F3189 Standard Test Method for Measuring Force Reduction, Vertical Deformation, and Energy Restitution of Synthetic Turf Systems Using the Advanced Artificial Athlete



Rotational Resistance

- EN 15301-1 Surfaces for sports areas - Part 1: Determination of rotational resistance



Ball Interaction



Ball Rebound

- **ASTM F2117-10** Standard Test Method for Vertical Rebound Characteristics of Sports Surface/Ball Systems; Acoustical Measurement
- **EN 12235:2013** Surfaces for sports areas - Determination of Vertical Ball Behavior
- **FIFA Test Method 01** Determination of Ball Rebound

Ball Roll

- **EN 12234:2013** Surfaces for sports areas - Determination of ball roll behavior
- **FIFA Test Method 03** Determination of Ball Roll

Ball Roll Deviation

- **FIH Hockey Turf and Field Standards** Part 2 - Clause 7.3

Surface Regularity

- **EN 13036-7:2003** Road and Airfield Surface Characteristics - Irregularity Measurement of Pavement Courses - The Straight Edge Test
- **FIFA Test Method 12** Procedure for the assessment of surface planarity



Protecting players' health during summertime

- Follow guidelines set by the Massachusetts Interscholastic Athletic Association
<https://miaa.net/wp-content/uploads/2022/09/MIAA-Heat-Modification-Policy-081821-amended-9-1-22CB.pdf>
- Measure and make decisions based on **wet bulb globe temperature (WBGT)**
- This measurement, WBGT, accounts not only for temperature, but also for humidity, solar radiation, and wind speed
- University of Georgia researchers (Grundstein & Cooper, 2020) measured WBGTs at players' heights at tennis court, synthetic field, and natural grass field in same athletic complex over four hot, humid, July days
 - Tennis court & synthetic field had higher **surface** temperatures; but the increased **humidity** over natural grass resulted in no differences in WBGTs

Environmental Considerations

Parks & Recreation Commission

Jay Peters and Dr. Laura Green

Environmental Considerations

- Synthetic turf systems drain vertically therefore they improve groundwater recharge and provide stormwater management benefits
- No fertilizer required
- No herbicide/pesticides required
- No irrigation required
- Reduced maintenance requirements
- Crumb rubber infill a recycled material diverting million of tires from landfills
- Natural infills sustainably harvested

Conservation Commission

Susan Chapnick

Environmental Considerations

- Wetland resource areas in Arlington
- Chemical run-off concerns
- Loss of habitat for insects and other invertebrates
- Loss of habitat for foraging for birds and small mammals
- Loss of wildlife corridor connectivity – disrupted habitats
- Heat effects at surface of fields
- Microplastic & particulate pollution from migration of infill and weathered blades

Migration of Tire Crumb Rubber and Broken Plastic Blades



Migration of infill into adjacent upland resource area to Mill Brook – field on left of cement barrier.
Arlington Catholic HS Field, December 2021
[photo: S. Chapnick]



Wetland Resources, Habitat & Wildlife

- **Zinc toxicity:** documented since 2010
 - “When infill is road tires, it contains Zinc. Zinc is toxic to fish.”
 - “The Chair is quite correct to be concerned about chemicals in recycled tires.” (Dr. Green, 1/5/23 at Conservation Commission meeting recording @ 1:23)
- **New Science 2022:** 6ppd-quinone from oxidized tire crumb rubber – direct toxicity to freshwater fish¹



Mill Brook/Cookes Hollow



River Herring [photo credit MyRWA]

¹ M. Brinkmann, et al., *Acute Toxicity of the Tire Rubber-Derived Chemical 6ppd-quinone to Four Fishes of Commercial, Cultural, and Ecological Importance*, Environmental Science & Technology, March 2022, v9, 4, pp 333-338

Sustainability

Conservation Commission

Susan Chapnick

Sustainability / Climate Impacts

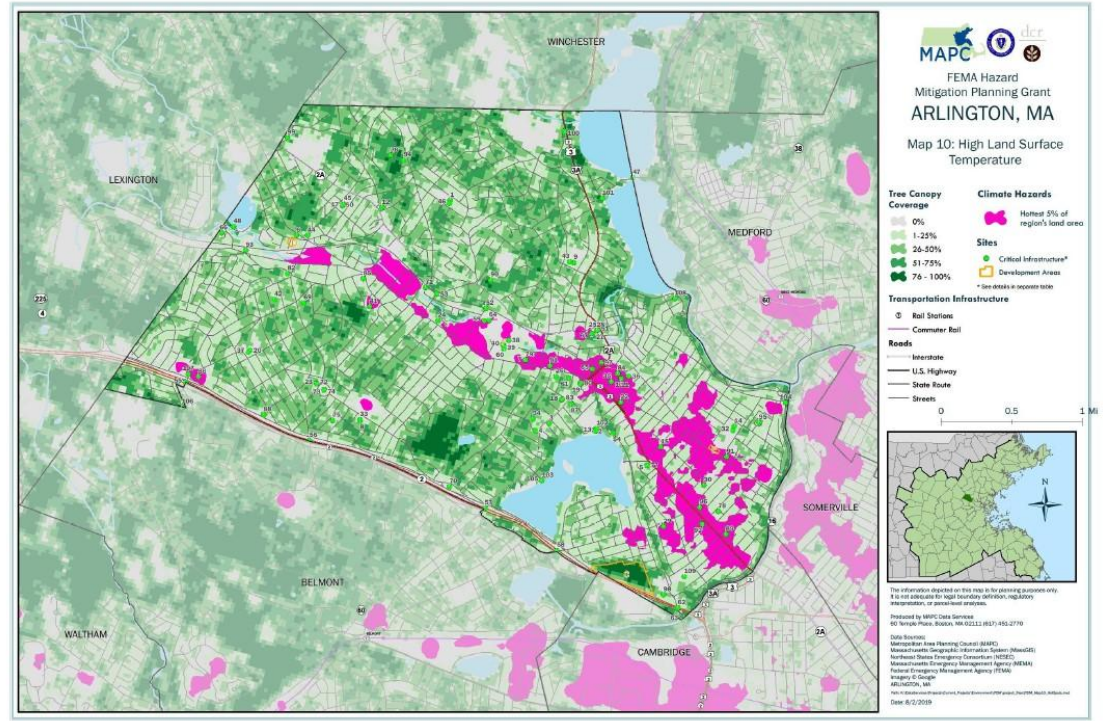
- **Recycling:** Current evidence shows that artificial turf cannot be meaningfully recycled. Most is sent to landfills or stockpiles.
- **Incineration:** burning of artificial turf is not a climate-resilient solution – produces air pollution / release of toxic chemicals
- **Fossil Fuels:** Many of the materials used in artificial turf are petroleum based / Plastics
- **Limited useful lifespan:** Artificial turf fields typically need to be replaced every 8-10 years



Piles of Artificial Turf in Franklin, MA. David L. Ryan / Globe Staff 2019

Climate Change Resilience Impacts

- **Heat:** Artificial turf contributes to the urban heat island effect
- **Loss of green space:** Replacing soil and plants with synthetic materials
- **Loss of a carbon sink:** Carbon sequestration is a climate resilience strategy that is lost with artificial turf



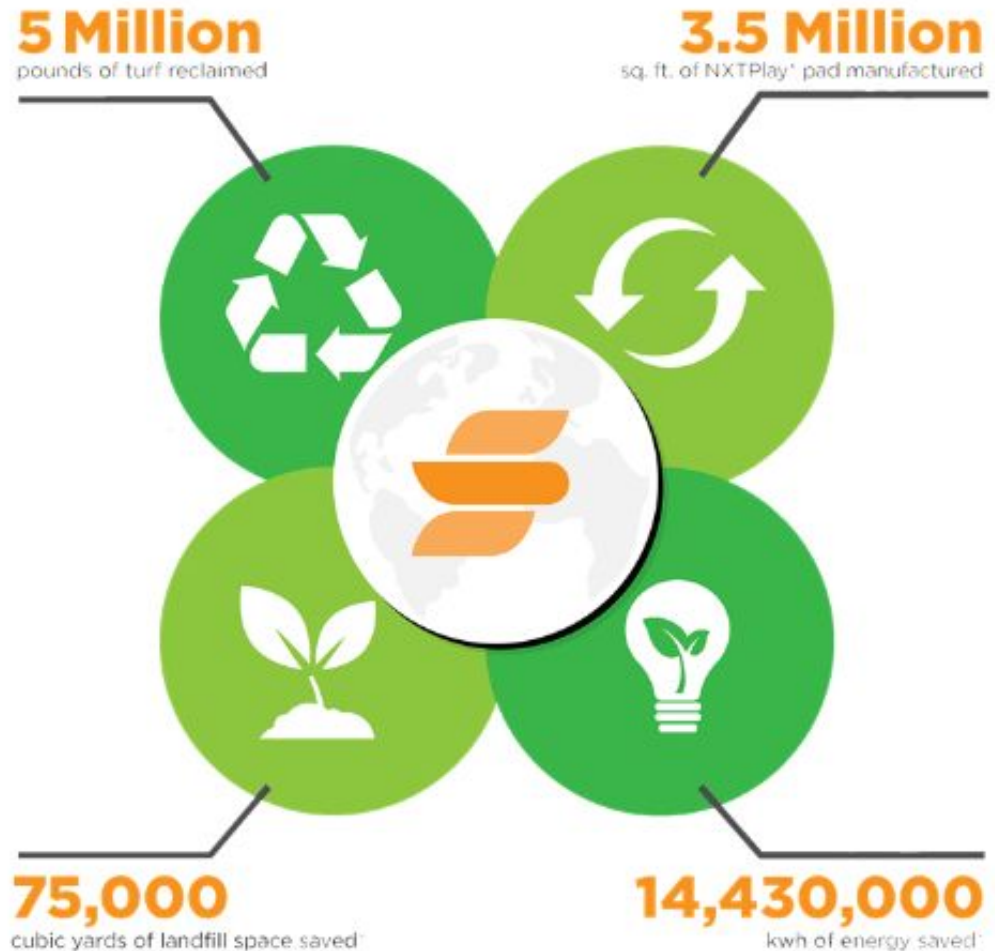
Arlington Hazard Mitigation Plan 2020 – Hottest 5% of region's land area

Parks & Recreation Commission

Jay Peters and Dr. Laura Green

Recycling

- Shock pads are cradle-to-cradle certified



Closing Statements

Parks & Recreation Commission

Summary Slide


- **All** sports fields have their pros and cons
- Site specific considerations should always predominate
- Stakeholders should always be involved in decision making
- Stakeholders are student-athletes, coaches, Town-administrators, School-administrators, parents, neighbors, etc.

Conservation Commission

Dr. Wendy Heiger-Bernays

Article

Comparison of WBGTs over Different Surfaces within an Athletic Complex

Andrew Grundstein ^{1,*} and Earl Cooper ² ¹ Department of Geography, University of Georgia, Athens, GA 30602, USA² Department of Kinesiology, University of Georgia, Athens, GA 30602, USA; cooperb@uga.edu

* Correspondence: andrewg@uga.edu

Received: 2 June 2020; Accepted: 22 June 2020; Published: 25 June 2020



Abstract: Many athletic governing bodies are adopting on-site measurement of the wet-bulb globe temperature (WBGT) as part of their heat safety policies. It is well known, however, that microclimatic conditions can vary over different surface types and a question is whether more than one WBGT sensor is needed to accurately capture local environmental conditions. Our study collected matched WBGT data over three commonly used athletic surfaces (grass, artificial turf, and hardcourt tennis) across an athletic complex on the campus of the University of Georgia in Athens, GA. Data were collected every 10 min from 9:00 a.m. to 6:00 p.m. over a four-day period during July 2019. Results indicate that there is no difference in WBGT among the three surfaces, even when considered over morning, midday, and afternoon practice periods. We did observe microclimatic differences in dry-bulb temperature and dewpoint temperature among the sites. Greater dry-bulb and lower dewpoint temperatures occurred over the tennis and artificial turf surfaces compared with the grass field because of reduced evapotranspiration and increase convective transfers of sensible heat over these surfaces. The lack of difference in WBGT among the surfaces is attributed to the counterbalancing influences of the different components that comprise the index. We conclude that, in a humid, subtropical climate over well-watered grass, there is no difference in WBGT among the three athletic surfaces and that, under these circumstances, a single monitoring site can provide representative WBGTs for nearby athletic surfaces.

Keywords: athletic surfaces; WBGT; weather; heat stress; safety

1. Introduction

Exertional heat illnesses (EHI) affect thousands of athletes each year and exertional heat stroke is among the leading causes of death among athletes [1]. Environmental monitoring coupled with activity modification is a key component of a well-designed heat policy [2,3]. Importantly, on-site measurements can better capture local microclimate conditions than remote observations from weather stations as differences in sheltering, surface type, or solar exposure can influence heat stress [4–6]. As such, regarding the interscholastic participant, numerous high school athletic associations now require on-site measurement of environmental conditions using the wet-bulb globe temperature (WBGT) [7]. A question that has been raised among sports medicine professionals is whether a single weather measurement can represent environmental conditions on nearby athletic fields when there are a variety of surfaces (e.g., grass, artificial turf, hardcourt tennis, etc.) used for athletic play or if measurements are required over each surface. Microclimatic conditions over small areas can be greatly affected by the characteristics of the underlying surface [8]. Multiple studies have identified that athletic surface type, especially artificial turf, alter surface temperatures relative to grass covered surfaces, and which may affect heat stress [9–13]. What has been less explored is how these surface changes impact ambient air temperatures and humidity levels above the athletic surfaces and integrated bioclimatic indices like

the WBGT [5,14–16]. Both the cost of WBGT sensors and the staffing to monitor multiple sensors may pose barriers to high schools or other organizations adopting the practice of monitoring environmental conditions where multiple sites are used. Our study seeks to identify if different athletic surfaces, which are commonly present on high school and college campuses, and other athletic/recreational facilities may affect WBGT measurements. In particular, we ask two key questions:

- (1) Does the WBGT vary by athletic surface (artificial turf, hardcourt tennis, and grass)?
- (2) Is a single monitoring station able to capture local WBGT conditions in an athletic complex?

2. Materials and Methods

WBGT data were collected over three different surface types commonly associated with the sports of American football, soccer, and tennis on the campus of the University of Georgia (UGA) in Athens, GA, USA over a five-day period, 24–28 July, 2019 (Figure 1). Athens, GA has a humid, subtropical climate characterized by hot and humid summers [17]. Data were collected over commonly used athletic surfaces, including natural grass, artificial turf (FieldTurf, Montreal, QC, Canada), and hardcourt tennis (Plexipave, Andover, MA, USA) surfaces, which were all located between 162 and 423 m of each other. The natural grass surface was well watered. The day before the study (23 July), 3.56 mm of precipitation was recorded at the on-site WeatherSTEM station and the grass field was watered between 2:30 a.m. and 3:30 a.m. on two days (26 and 28 July) during the study. Three WBGT monitors (Kestrel 5400 heat stress meters, Nielsen-Kellerman, Boothwyn, PA, USA) were set on a tripod at each site in a sunny location that would not be subjected to shade (other than cloud cover) during the data collection period. In addition, the locations we selected were at least 15 m from another surface type and had sheltering that would reduce the effects of local advection. The tennis court, for instance, is located adjacent to an asphalt parking lot but is separated by a mesh covered fence that would reduce wind speeds.



Figure 1. Map of study locations with site photographs. The distance between tennis and grass surfaces is 424 m, artificial turf and tennis surfaces is 317 m, and artificial turf and grass surfaces is 162 m. WxSTEM refers to the on-site weather station.

Over each surface, the WBGT monitors were set up on the tripods at 1.2 m above the surface to represent an anthropometric scale [18]. The dry-bulb temperature, natural wet-bulb temperature, globe temperature, dewpoint temperature, and wind speed were collected every 10 min from

9:00 a.m. to 6:00 p.m. The WBGT was computed as a weighted average of the dry-bulb temperature (DB), natural wet-bulb temperature (WB), and globe temperature (GT) using the following equation [19]:

$$\text{WBGT} = 0.7 \times \text{WB} + 0.2 \times \text{GT} + 0.1 \times \text{DB}. \quad (1)$$

We followed the manufacturer's recommendation and allowed the unit to equilibrate for 15 min prior to collecting data for analysis [20]. Observations with relative humidity <15% or >95% were removed from the dataset as they exceed the specification range for sensor accuracy [21]. For comparison purposes, only times when all three surfaces had viable observations were retained. In total, 243 observations from each surface were compared. These observations were divided into three different practice periods: morning (9:00–11:59 a.m., $n = 63$), midday (noon–2:59 p.m., $n = 90$), and afternoon (3:00–5:59 p.m., $n = 90$). Weather data (e.g., temperature, humidity, wind speed, and solar radiation) were collected from a WeatherSTEM station that is located within the sports complex (Figure 1). This weather dataset was used to identify the overall weather conditions during the study days [22].

Summary statistical measures were used to quantify WBGTs and other meteorological variables among the surfaces, with a focus on median for central tendency and interquartile range for variability as not all data distributions were normal. Normality was determined using the Kolmogorov–Smirnov test and visual inspection of the Q–Q plot and histogram. Pearson's correlation coefficient was used to assess the association of WBGTs between the surfaces (i.e., grass vs. artificial turf; grass vs. tennis, and artificial turf vs. tennis) and the relationship between the WBGT over a particular surface with weather station data (e.g., temperature, dewpoint temperature, wind speed, and solar radiation). ANOVA (or Kruskal–Wallis one-way analysis of variance on ranks when the required assumptions were not met) was used to compare the effect of athletic surface type on WBGT values using $\alpha = 0.05$. A similar approach was used to assess the effect of surface type on the WBGT components as well as dewpoint temperature. All statistical analyses were completed using SPSS (version 26; IBM Corp, Armonk, NY, USA).

3. Results

3.1. Weather Conditions

Weather conditions were determined from a centrally located weather observing station (Figure 1). Over the five-day study, maximum air temperatures ranged from 30.3 to 32.6 °C and minimum temperatures were between 17.7 and 20.2 °C (Figure 2a). Average daily dewpoint temperature varied from 15.6 to 19.4 °C (Figure 2a). Maximum solar radiation exceeded 1000 W m^{−2} each day (1032–1097 W m^{−2}) with considerable variability, particularly in the afternoon in response to changing cloud cover (Figure 2b). Based on 11 years (2009–2019) of July data from a nearby weather station at the UGA Climatology Research Laboratory (~1.8 km from study site with a longer period of record than the WeatherSTEM station), the study days had lower than average maximum daytime temperatures (long-term mean = 33.2 °C) and humidity (long-term mean = 22.5 °C) but peak solar radiation values that were close to average.

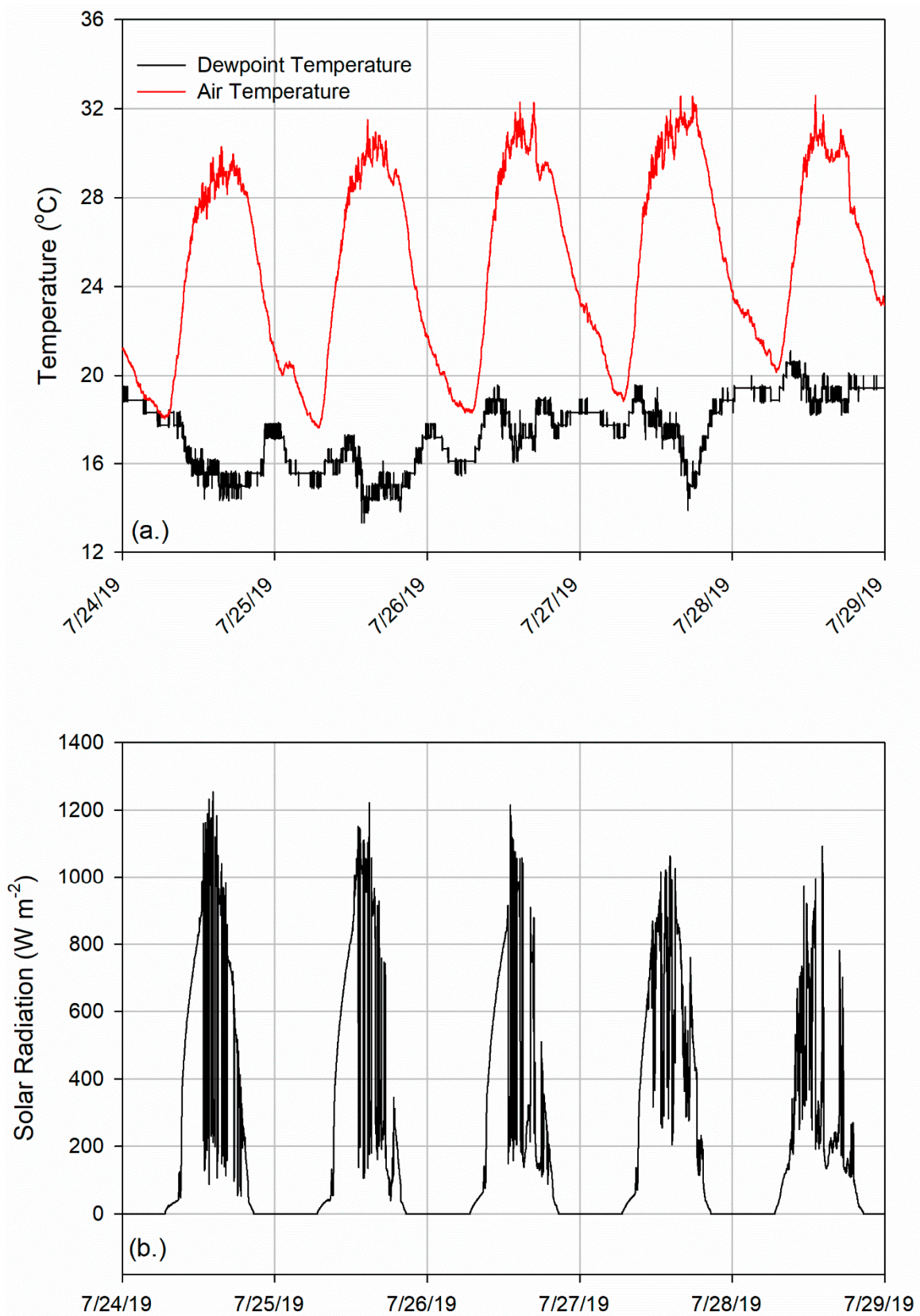


Figure 2. Weather conditions at on-site WeatherSTEM observing station: (a) air temperature and dewpoint temperature and (b) solar radiation.

3.2. Differences in WBGT among Athletic Surfaces

A wide variety of WBGTs occurred over the study period, ranging from as low at 22.9 °C up to 32.2 °C (Figure 3). In the morning period, median WBGTs ranged between 25.94 and 26.83 °C among the surfaces with median values slightly greater (0.78–0.89 °C) over grass than tennis or artificial turf surfaces, respectively. During the midday period, median WBGTs were greater relative to both the morning and afternoon practice times, with values ranging from 27.33 to 27.67 °C. This period had the smallest difference among median WBGTs, with artificial turf 0.06 °C greater and tennis 0.33 °C greater than grass. Finally, WBGTs decreased in the afternoon period relative to midday, with median values between 25.83 and 26.42 °C. Both artificial turf and tennis surfaces had slightly greater WBGTs than grass by approximately 0.56–0.58 °C. The afternoon had the largest variance of WBGTs values with the interquartile (75th–25th percentile) range from 3.01 to 3.19 °C compared with 2.33–2.89 °C for morning and 2.51–2.81 °C for midday. The athletic surface type did not have a significant effect on WBGT at the $p < 0.05$ level in any of the practice periods: $F(2,186) = 2.828$, $p = 0.062$ for morning, $F(2,267) = 0.254$, $p = 0.776$ for midday, and $F(2,267) = 0.831$, $p = 0.437$.

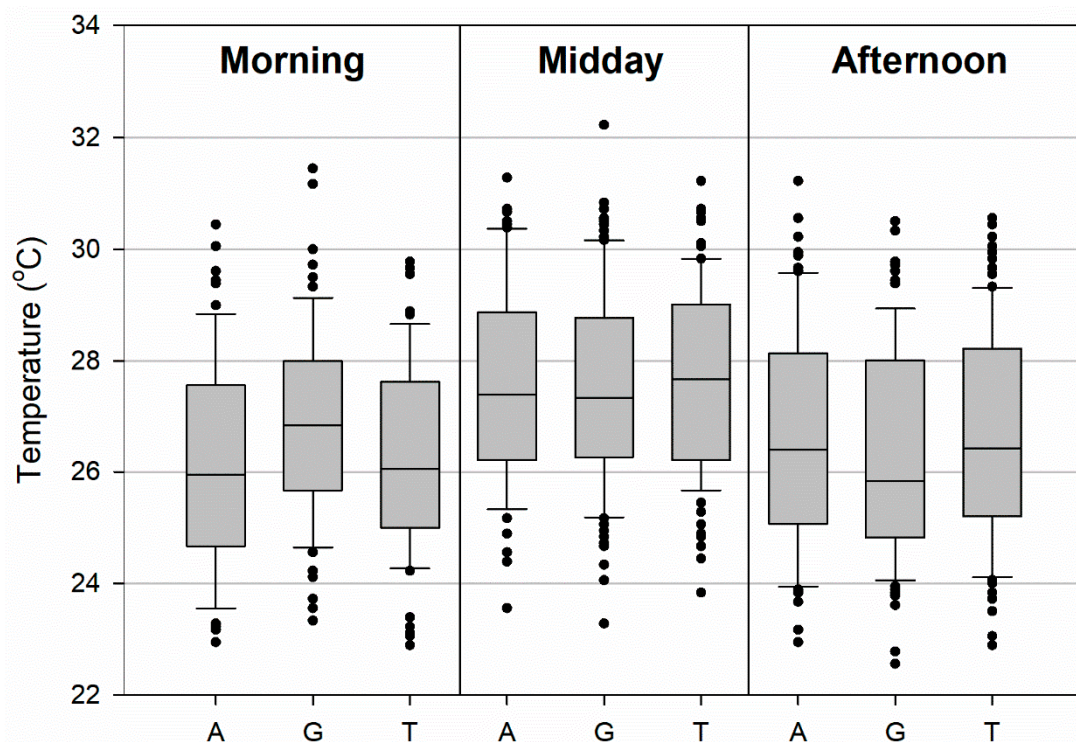


Figure 3. Box plots of wet-bulb globe temperature (WBGT) for artificial turf (A), grass (G), and hardcourt tennis (T) athletic surfaces for morning (9:00–11:59 a.m.), midday (noon–2:59 p.m.), and afternoon (3:00–5:59 p.m.) practice sessions. The boundaries of the box represent the 25th and 75th percentiles, the line within the box indicates the median, the whiskers are the 10th and 90th percentiles, and the points above and below are the outliers, respectively.

We observed strong correlations between the WBGTs of each surface, ranging from $r = 0.89$ – 0.92 in the morning, 0.81 – 0.90 during midday, and 0.90 – 0.93 in the afternoon. This is well illustrated in Figure 4 for 26 July between 11:00 a.m. and 5:59 p.m. where WBGTs over each surface type vary together in close association with recorded solar radiation levels. Of note are the large swings in WBGT by up to 5–6 °C in magnitude over short time periods (10 min) in response to changing solar radiation. In fact, over the study period, WBGTs were most highly correlated with changes in solar radiation ($r = 0.60$ – 0.66 ; Table 1). There were smaller correlations between WBGTs and air temperature (0.32 – 0.52) and dewpoint temperature (0.15 – 0.23).

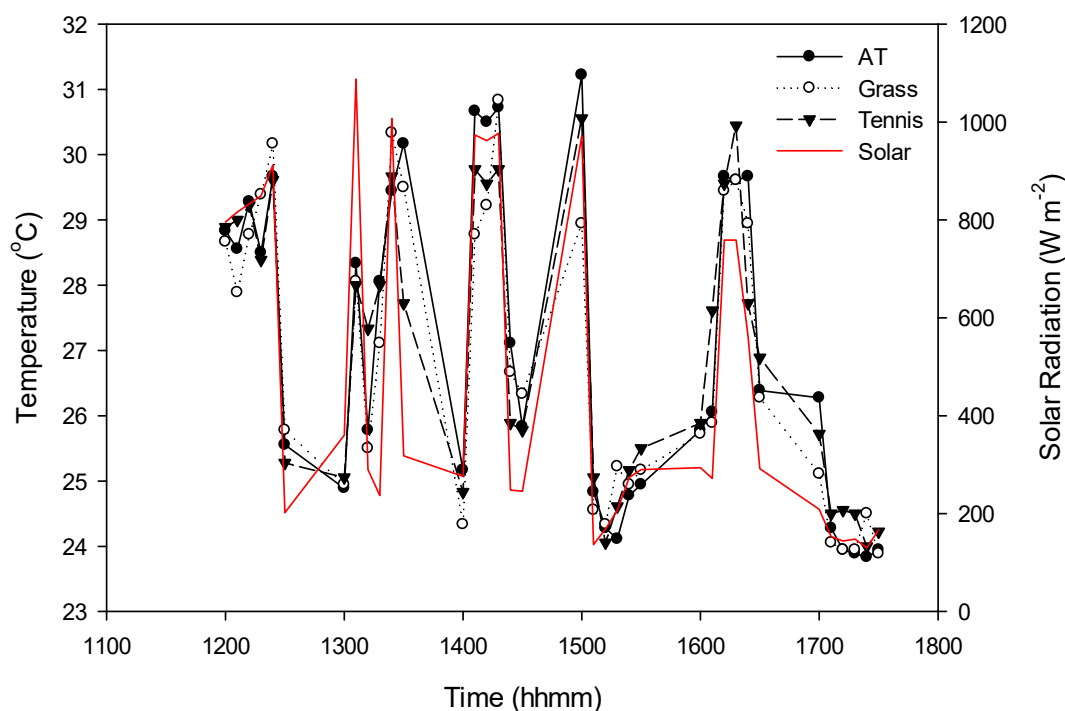


Figure 4. WBGTs and solar radiation by athletic surface for 26 July 2019 during the midday and afternoon periods. AT is artificial turf.

Table 1. Athletic surface WBGT correlations ($n = 242$ observations) with weather variables measured at the on-site WeatherSTEM observing station. AT is artificial turf.

	AT WBGT	Grass WBGT	Tennis WBGT
Dry-bulb Temperature	0.52	0.32	0.50
Dewpoint Temperature	0.22	0.23	0.15
Solar Radiation	0.60	0.65	0.66

3.3. Differences in Microclimates among Athletic Surfaces

We observed differences in the component parts of the WBGT as well as dewpoint temperature among the surfaces in the different time periods (Figure 5). In the morning, artificial turf and tennis have slightly warmer median dry-bulb temperatures (0.56–0.61 °C), but median dewpoints were 0.95–1.17 °C lower and wet-bulb temperatures were 0.61–0.94 °C lower than grass (Figure 5a). Median globe temperatures were greater over grass (+0.94 °C) and tennis (+0.72 °C) surfaces than artificial turf. The athletic surface type had a statistically significant effect on dewpoint temperature ($F(2,186) = 3.583$, $p = 0.030$). Post hoc comparisons using the Tukey HSD test indicated that the mean score was significantly different between grass and tennis surfaces ($M = 0.732$, $p = 0.027$). In addition, the surface type had a significant effect upon wet-bulb temperature ($F(2,186) = 4.970$, $p = 0.008$), with post hoc comparisons indicating that the mean value was significantly different between tennis and grass surfaces ($M = -0.722$, $p = 0.022$) and between artificial turf and grass surfaces ($M = -0.7469$, $p = 0.017$).

During midday, artificial turf and tennis surfaces had greater median dry-bulb temperatures by 0.83 to 1.06 °C, but dewpoints were 0.91 to 1.11 °C lower, and wet-bulb temperatures were 0.28 to 0.44 °C lower than measurements taken over grass. Median globe temperatures were greater (+1.42 to 1.53 °C) over the artificial turf and tennis court surfaces than the grass field (Figure 5b). The interquartile differences for the globe temperature over the three surfaces (approximately 6–8 °C) were greater than for dry-bulb, dewpoint, and wet-bulb temperatures (approximately 2–3 °C), indicating the greater dispersion of observations. Unlike in the morning, the athletic surface type had a statistically significant effect on dry-bulb temperatures ($F(2,267) = 9.502$, $p = 0.000$). Post hoc comparisons using the Tukey

HSD test indicated that the mean dry-bulb temperature was significantly different between artificial turf and grass surfaces ($M = 0.836$, $p = 0.001$) and between tennis and grass ($M = 0.934$, $p = 0.000$). In addition, the surface type had a significant effect upon the dewpoint temperature ($H(2) = 16.60$, $p = 0.000$). Results from the pairwise tests using the Bonferroni correction show significant differences between tennis and grass ($p = 0.001$) and artificial turf and grass ($p = 0.002$) with respect to dewpoint measurements. Surface type had a significant effect upon globe temperatures ($H(2) = 6.22$, $p = 0.045$) but pairwise tests using the Bonferroni correction do not show any significant differences. This may have occurred because of the weakly significant global effect with the p -value near the 0.05 threshold.

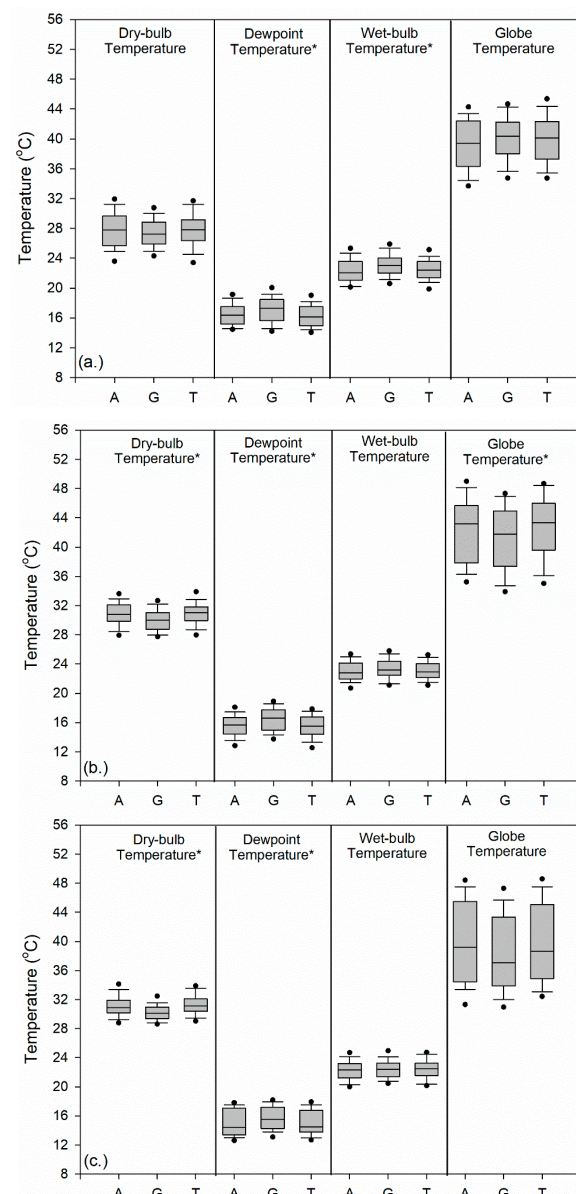


Figure 5. Box plots of WBGT components and other meteorological variables among artificial turf (A), grass (G), and hardcourt tennis (T) athletic surfaces for (a) morning (9:00–11:59 a.m.), (b) midday (noon–2:59 p.m.), and (c) afternoon (3:00–5:59 p.m.) practice sessions. The boundaries of the box represent the 25th and 75th percentiles, the line within the box indicates the median, the whiskers are the 10th and 90th percentiles, and the points above and below the whiskers are the 5th and 95th percentiles, respectively. Note that surface type had a statistically significant effect upon globe temperatures during midday but pairwise tests do not show any significant differences. * indicates statistically significant at $p < 0.05$.

Finally, during afternoon practices, artificial turf and tennis surfaces had greater median dry-bulb temperatures (0.81 to 1.00 °C) but lower dewpoint (1.06 to 1.09 °C lower) and wet-bulb temperatures (0.08 to 0.11 °C lower) than over grass (Figure 5c). Median globe temperatures were 1.61 to 2.19 °C greater over artificial turf and tennis surfaces than grass. The interquartile range for the globe temperature over the three surfaces (approximately 9–11 °C) are greater than for dry-bulb, dewpoint, and wet-bulb temperatures which are about 2–4 °C. Similar to midday, the athletic surface type had a statistically significant effect on dry-bulb temperatures ($H(2) = 30.147$, $p = 0.000$). Results from the pairwise tests using the Bonferroni correction show significant differences between artificial turf and grass ($p = 0.000$) and tennis and grass ($p = 0.000$) surfaces. The surface type also had a significant effect upon the dewpoint temperature ($H(2) = 9.486$, $p = 0.009$). Results from the pairwise tests using the Bonferroni correction show significant differences in dewpoint temperature between artificial turf and grass ($p = 0.015$) and tennis and grass ($p = 0.037$) surfaces.

4. Discussion

We did not find a difference in median WBGTs among three different athletic surfaces during any of the three practice periods. However, microclimatic differences in dry-bulb temperature, dewpoint temperature, and wet-bulb temperature among the surfaces were observed at various times and help to explain the lack of difference in WBGT.

In the morning, we found statistically significant differences in dewpoint temperature and wet-bulb temperature but no difference in dry-bulb or globe temperatures. Grass and the underlying soil can add moisture to the air via evapotranspiration, increasing dewpoint temperatures compared with impervious surfaces, like the tennis court or artificial turf surfaces, that are designed to quickly drain away water [13,23]. The wet-bulb temperature is a function of multiple variables, including solar radiation, dry-bulb temperature, wind speed, and humidity [24]. Given no statistical difference in dry-bulb temperature and solar radiation among surfaces during this period, the greater wet-bulb temperature over grass is driven by the greater atmospheric moisture as indicated by the higher dewpoint temperature.

During midday and afternoon, we observed statistically significant differences among surfaces in dry-bulb and dewpoint temperatures. The artificial turf and tennis surfaces had greater median dry-bulb but lower dewpoint temperatures than the grass surface. The hotter dry-bulb temperature is in line with previous research and associated the greater transfers of sensible heat via convection of hotter air from the drier surfaces [13–15]. As in the morning, the greater dewpoint temperature over the grass field is related to the evapotranspiration of moisture into the lower atmosphere. The lack of significant difference in wet-bulb temperature is due to counteracting factors. As mentioned above, wet-bulb temperature is a function of multiple meteorological variables. Over the artificial turf and tennis surfaces, the greater dry-bulb temperature would serve to increase the wet-bulb temperature, but the lower dewpoint temperature would offset this increase. In contrast, the lower dry-bulb temperature over the grass surface would decrease the wet-bulb temperature, but this would be offset by the greater dewpoint temperature. This finding is different than observed by Kandelin et al. (1976) who observed a greater wet-bulb temperature over artificial turf when compared with a grass field [14]. An explanation for this is that the Kandelin study did not measure humidity independently over each surface but rather used one measurement. Thus, the higher wet-bulb temperatures over the artificial turf are driven by the greater air temperatures. Lastly, the globe temperature is determined by several factors including solar radiation, air temperature, and wind [24]. While the greater dry-bulb temperatures over the tennis and artificial turf surfaces may slightly increase the globe temperature, the small overall difference among surfaces is likely due to the similar solar radiation inputs experienced by the nearby study sites. In sum, given the high weight of the wet-bulb temperature (which was not different among sites) in the WBGT computation, the small differences in dry-bulb and globe temperatures did not lead to a statistically significant difference in the WBGT.

Our findings are consistent with those of Kopec (1977) who also compared WBGT among different surface types (e.g., hardcourt tennis, artificial turf, and grass) in a similar humid subtropical climate [16]. He observed only small differences in WBGT between the grassy control site and other sites, likely due to counteracting variables in the WBGT equation and the heavy weighting of the wet-bulb temperature component. For instance, a detailed case study between the grassy control site and an artificial turf field showed that the artificial turf surface had greater average dry-bulb and globe temperatures but a slightly lower wet-bulb temperature. The magnitude of the average differences in both dry-bulb (2.2 °C) and globe temperatures (3.6 °C) were greater than those found in this study, however. Possible explanations may be the differences in thermal characteristic of the artificial turf surfaces (Astroturf vs. FieldTurf), the short period of the Kopec's case study (two hours on a single day), and the distance between sites which could influence solar radiation. In fact, Kopec (1977) hypothesized that solar radiation in response to changing cloud cover rather than surface type was the key driver of WBGT variations between sites in his study. We similarly found that changes in solar radiation were highly correlated with WBGT and resulted in large swings in values, regardless of surface, over short time periods. However, the nearness of our three sites allowed us to control for solar radiation as a factor in explaining instantaneous differences in WBGT.

In our study, we identified some limitations that may impact our findings. First, our study was performed in a humid, subtropical climate with a well-watered grass surface. Further research is needed to confirm if our findings can be more broadly applied to conditions when the grass surface may have low soil moisture, whether due to a drought or the prevailing climate (e.g., arid region), which could influence evapotranspiration and low-level moisture [25]. Second, we focused on three common athletic surface types. While further work is needed to confirm our findings over different surfaces such as rubberized track surfaces or brick dust often used with baseball and softball infields, our work is suggestive that variability in solar radiation creates larger WBGT variations within surface type than between surface type. Third, our study focused narrowly on whether WBGT varied by athletic surface type. We cannot conclude there is no difference in heat stress to athletes among athletic surfaces. In addition, our results should not be generalized to other heat indices. Other measures, such as the heat index, have different assumptions and input variables than the WBGT, which could affect whether there are meaningful differences in the index values among athletic surfaces. Finally, our results are applicable to nearby sites (less than 0.5 km). Longer distances may influence solar radiation variability between sites.

5. Conclusions

Our study indicates that in a humid, subtropical climate over a well-watered grass field, there is no difference in WBGT when compared to artificial turf and hardcourt tennis surfaces. Yet, there are clear microclimatic differences in dry-bulb and dewpoint temperatures among the three surfaces that provide counterbalancing influences on components of the WBGT, ultimately limiting the total difference in the index. Thus, a single monitoring site is sufficient to capture representative WBGTs over a variety of commonly used athletic surfaces in close proximity, when meeting our study conditions.

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Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Casa, D.J.; Stearns, R.L. *Preventing Sudden Death in Sport and Physical Activity*; Jones & Bartlett: Burlington, MA, USA, 2017.
2. Armstrong, L.E.; Casa, D.J.; Millard-Stafford, M.; Moran, D.S.; Pyne, S.W.; Roberts, W.O. American College of Sports Medicine position stand. Exertional heat illness during training and competition. *Med. Sci. Sports Exerc.* **2007**, *39*, 556–572. [[CrossRef](#)] [[PubMed](#)]
3. Casa, D.J.; DeMartini, J.K.; Bergeron, M.F.; Csillan, D.; Eichner, E.R.; Lopez, R.M.; Ferrara, M.S.; Miller, K.C.; O'Connor, F.; Sawka, M.N.; et al. National Athletic Trainers' Association position statement: Exertional heat illnesses. *J. Athl. Train.* **2015**, *50*, 986–1000. [[CrossRef](#)] [[PubMed](#)]
4. Chevront, S.N.; Cauro, E.M.; Heavens, K.R.; Karis, J.; Santee, W.R.; Anos, C.T.; D'Hemecourt, P.D. Effect of WBGT Index Measurement Location on Heat Stress Category Classification. *Med. Sci. Sports Exerc.* **2015**, *47*, 1958–1964. [[CrossRef](#)] [[PubMed](#)]
5. Pryor, L.J.; Pryor, R.R.; Grundstein, A.; Casa, D.J. The heat strain of various athletic surfaces: A comparison between observed and modeled wet-bulb globe temperatures. *J. Athl. Train.* **2017**, *52*, 1056–1064. [[CrossRef](#)] [[PubMed](#)]
6. Tripp, B.; Vincent, H.K.; Bruner, M.; Smith, S.M. Comparison of wet bulb globe temperature measured on-site vs. estimated and the impact on activity modification in high school football. *Int. J. Biometeorol.* **2020**, *64*, 593–600. [[CrossRef](#)] [[PubMed](#)]
7. State High School Safety Policies. Available online: <https://ksi.uconn.edu/high-school-state-policies-2/> (accessed on 10 November 2019).
8. Williams, T.B. Microclimatic temperature relationships over different surfaces. *J. Geogr.* **1991**, *9*, 285–291. [[CrossRef](#)]
9. Buskirk, E.R.; McLaughlin, E.R.; Loomis, J.L. Microclimate over artificial turf. *J. Health Phys. Educ. Recreat.* **1971**, *42*, 29–30. [[CrossRef](#)]
10. McNitt, A.S. Synthetic turf in the USA: Trends and issues. *Int. Turfgrass Soc. Res.* **2005**, *10*, 27–33.
11. Petrass, L.A.; Twomey, D.M.; Harvey, J.T.; Otago, L.; Le Rossignol, P. Comparison of surface temperatures of different synthetic turf systems and natural grass: Have advances in synthetic turf technology made a difference. *J. Sports Eng. Technol.* **2015**, *229*, 10–16. [[CrossRef](#)]
12. Twomey, D.M.; Petrass, L.A.; Harvey, J.T.; Otago, L.; Le Rossignol, P. Selection of management of sports grounds: Does surface heat matter? *J. Facil. Plan. Des. Manag.* **2016**, *4*, 33–47.
13. Jim, C.Y. Solar-terrestrial radiant-energy regimes and temperature anomalies of natural and artificial turf. *Appl. Energy* **2016**, *173*, 520–534. [[CrossRef](#)]
14. Kendelin, W.W.; Krahenbuhl, G.S.; Schact, C.A. Athletic field microclimates and heat stress. *J. Saf. Res.* **1976**, *8*, 106–111.
15. Williams, C.F.; Pulley, G.E. *Synthetic Surface Heat Studies*; Brigham Young University: Provo, UT, USA, 2002; Available online: <https://aces.nmsu.edu/programs/turf/documents/brigham-young-study.pdf> (accessed on 10 January 2020).
16. Kopec, R.J. Response of the wet-bulb-globe-thermometer heat stress index to selected land use surfaces. *Southeast. Geogr.* **1977**, *17*, 133–145. [[CrossRef](#)]
17. Climate of Georgia. Available online: https://www.ncdc.noaa.gov/climate normals/clim60/states/Clim_GA_01.pdf (accessed on 20 March 2020).
18. Santee, W.; Matthew, W.; Blanchard, L. Effects of meteorological parameters on adequate evaluation of the thermal environment. *J. Therm. Biol.* **1994**, *19*, 187–198. [[CrossRef](#)]
19. Yaglou, C.P.; Minard, D. Control of heat casualties at military training centers. *Arch. Indust. Health* **1957**, *16*, 302–316.
20. Users Guide Kestrel 5400 Heat Stress Tracker. Available online: <https://kestrelinstruments.com/mwdownloads/download/link/id/14/> (accessed on 1 December 2019).
21. Kestrel Certificate of Conformity. Available online: https://cdn.shopify.com/s/files/1/0084/9012/t/11/assets/5000_Certificate_of_Conformity_specs.pdf (accessed on 1 December 2019).
22. Athens-Clarke WeatherSTEM. Available online: <https://athensclarke.weatherstem.com/> (accessed on 10 September 2019).
23. Henry, J.A.; Dirks, S.E.; Marotz, G.A. Urban and rural humidity distributions: Relationships to surface materials and land use. *J. Climatol.* **1985**, *5*, 53–62. [[CrossRef](#)]

24. Liljegren, J.C.; Carhart, R.A.; Lawday, P.; Tschopp, S.; Sharp, R. Modeling the Wet Bulb Globe Temperature Using Standard Meteorological Measurements. *J. Occup. Environ. Hyg.* **2008**, *5*, 645–655. [[CrossRef](#)] [[PubMed](#)]
25. Adegoke, J.O.; Pielke, R.A., Sr.; Eastman, J.; Mahmood, R.; Hubbard, K.G. Impact of irrigation on midsummer surface fluxes and temperature under dry synoptic conditions: A regional atmospheric model study of the U.S. High Plains. *Mon. Weather Rev.* **2003**, *131*, 556–564. [[CrossRef](#)]



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Connelly Attachment 3



Athletic Fields Projects at Lincoln Park: Field #1 Renovation

March 1, 2023



Who is “Lexington Recreation”?



Recreation and Community Programs Department

- Town department responsible for day-to-day operations and oversight of recreation programs and facilities and the community center.
- Executive staff: Melissa Battite (Director), Christine Dean (Community Center Director), Peter Coleman (Assistant Director of Recreation)

Recreation Committee

- Town Manager-appointed committee of residents responsible for making recreation-specific policy decisions and for providing guidance to the Recreation and Community Programs Dept.
- Recreation Committee members: Rick DeAngelis (Chair), Christian Boutwell (Vice Chair), Lisa O'Brien, Carl Fantasia, Claire Sheth, Weiwei Li, Renen Bassik

The Committee and Department work together to provide quality recreational opportunities for all residents of Lexington.



Project-specific Architects & Engineers



Activitas, Inc:

- Patrick Maguire, Owner and Managing Principal and Meg Buczynski, Principal Civil Engineer
- Activitas is a landscape architecture and civil engineering company with a focus on outdoor recreational and athletic design. Meg Buczynski, PE is a Board Member of the American Sports Builders Association and is one of two designers in the country with ASBA's Professional Certificate of Distinction.
- Patrick and Meg led the original design team (under a previous company) that conducted the first technical evaluation of athletic fields and park renovations at Lincoln Park in 2002, and their recommendations were implemented in 2003 leading to the facility we have today.
- Lexington has continued a highly productive relationship with Activitas for design and project management of athletic facilities projects including, but not limited to, the natural grass fields at the Center Recreation Complex, the award-winning Center Track and Field, and the upcoming Gallagher and Farias Courts renovation.

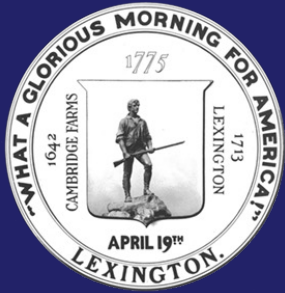


Project-specific Architects & Engineers



Haley and Aldrich: Environmental and Geotechnical Engineering

- Keith Johnson, LSP is the Licensed Site Professional that oversaw design and implementation of the renovations at Lincoln Park in 2003 and the subsequent monitoring requirements in relation to the underlying landfill.
- Jay Peters, Principal Risk Assessor, is a leading expert in developing risk-based strategies for managing and redeveloping contaminated sites under regulatory frameworks. Jay's expertise includes review of primary scientific literature to evaluate the human and environmental health risks of various compounds including those found in synthetic turf components.
- Haley & Aldrich has been a key partner with Lexington and Activitas in the safe development of Lincoln Park from a town dump to a first-class active and passive recreation facility.



How is Lexington Recreation funded?



Recreation Programs and Operations

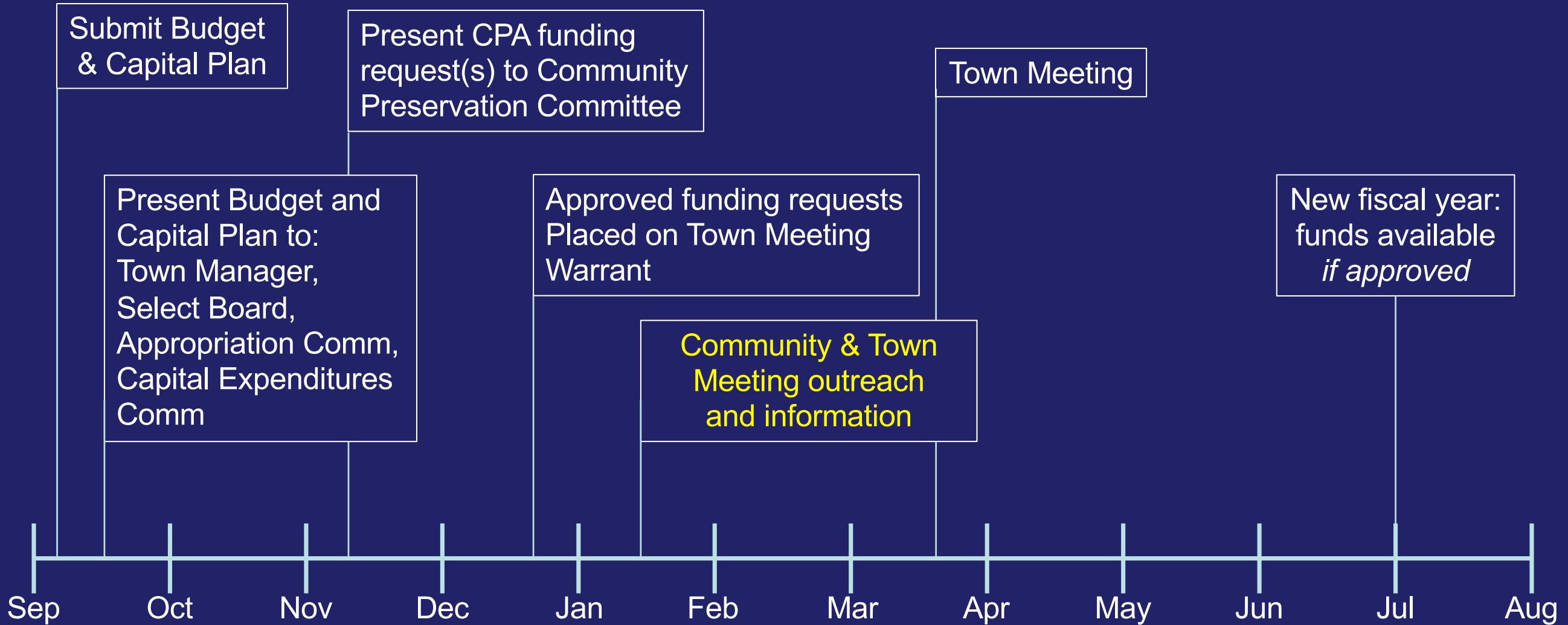
- Recreation programs are funded by **user fees**, which are collected and managed independently of other Town funds in the Recreation Enterprise Fund (Rec EF).
- The Recreation Enterprise Fund is a municipal financial structure that isolates Recreation revenue and expenses from the general operating fund and resident taxes.
- Lexington resident taxes do not regularly* fund Lexington Recreation operations. (*COVID exception).

Recreation Capital Projects

- Capital projects to support Lexington Recreation fields and facilities are funded at the discretion of Annual Town Meeting.
- Capital project funding sources include the Recreation Enterprise Fund, Community Preservation Act (CPA) funds, and the tax levy.
- Recreation capital projects typically follow a multi-year process of review by numerous boards and committees.



Annual Recreation Funding Timeline





Recreation 5-Year Capital Plan



Every fall as part of the annual Town budget setting process the Rec Dept. and Committee submit a departmental budget and proposed capital projects for the upcoming fiscal year and a 5-Year Capital Plan for review by the: Town Manager's Office, Select Board, Capital Expenditures Committee, Appropriation Committee, and the Community Preservation Committee (CPA proposals).

Annual Town Meeting ultimately votes on the annual Recreation Dept budget and on capital projects proposed for the coming fiscal year.

Most Recreation capital projects appear on the 5-Year Capital Plan for multiple years providing ample opportunity for review, discussion, and consideration by Town staff, boards, committees, Town Meeting members, and the community prior to eventual the Town Meeting vote.



Recreation Capital Projects Evaluation

We attempt to balance multiple goals when considering future capital projects including:

- fulfilling the official Recreation Committee charge;
- maintaining the current level of facilities and services;
- sustaining the fiscal health of the Recreation Enterprise Fund;
- responding to community needs including as identified by the 2020 Community Needs Assessment, the Recreation Facilities and ADA Compliance Study (2017), and direct resident communication;
- aligning with the goals and priorities of other Town boards and committees including the Select Board, the Conservation Commission, and the Lincoln Park Sub-Committee;
- enhancing the facilities and services provided to residents and;
- honoring Town bylaws and Town Meeting resolutions.



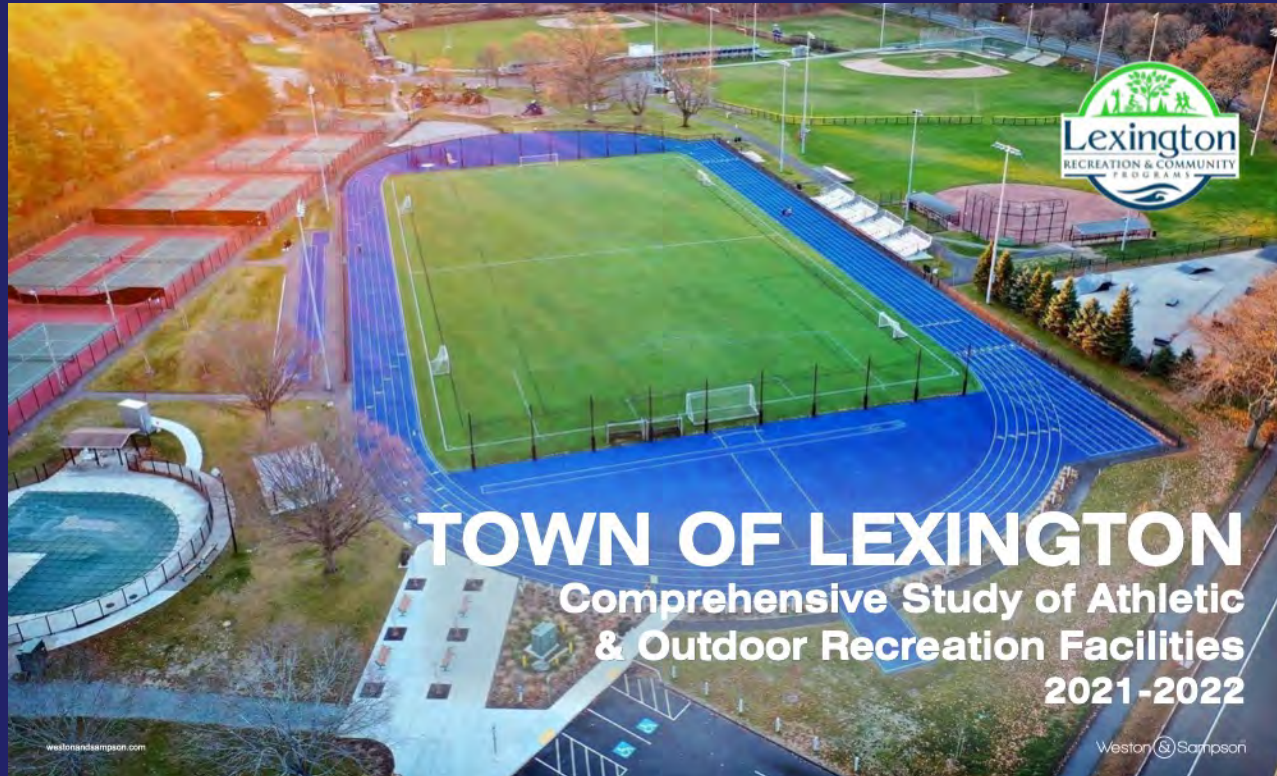
Lincoln Field Capital Projects

- Lincoln Field #1 was last renovated in 2015 with an expected lifespan of 8-10 years.
- The Lincoln Field #1 end-of-life field replacement project has long been presented on our 5-year capital plan for FY25.
- Two developments led to acceleration of the project to FY24:
 1. Annual safety testing indicated the current field merits earlier replacement.
 2. The anticipated closure of fields during LHS building project necessitates maximizing availability of Lincoln Fields.

Why is it critical to maximize the availability of Lincoln Fields?



Lexington Athletic Field Supply & Demand

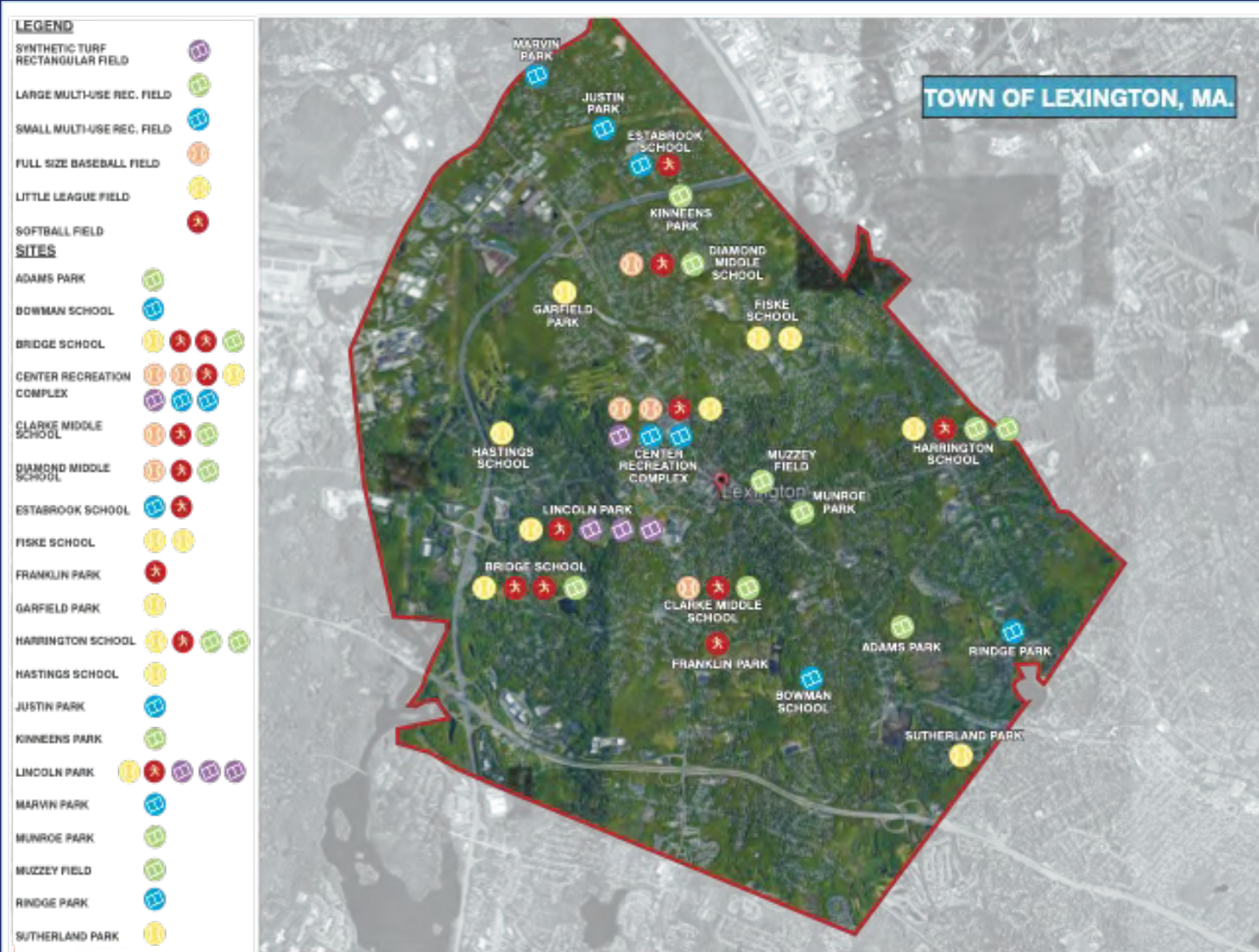


Complete report is available via the Capital Projects tab at:
www.lexingtonma.gov/511/Recreation-Community-Programs

- In 2019, Recreation was asked to formally quantify athletic field needs in Lexington and funding was approved at 2020 Annual Town Meeting for an external consultant to conduct a comprehensive analysis of field supply and demand.
- In 2022 Weston and Sampson, LLC provided the results of their analysis of field supply and demand including options to address identified supply deficiencies.



1. Rectangle Field Hours Deficit



- Study evaluated 20 athletic sites comprising an effective field inventory of 15.5 diamond fields, 15 natural grass rectangle fields, and 4 synthetic turf rectangle fields.
- This field inventory can sustainably support 21,600 hours/yr of use but is currently used 27,700 hours/yr.

Currently, Lexington operates at a field deficit equivalent to 8 large rectangle fields.



Anticipated LHS-associated Field Closures



LHS building project lay down area is currently anticipated to impact most fields at the Center Recreation Complex ~ 2026-2030.

Anticipated Center Rec Field Closures:

- varsity softball field
- varsity baseball field
- Harold Crumb football field
- JV baseball field
- Worthen practice field
- Fitzgerald little league field





LHS-associated Field Closures Will Substantially Decrease Field Availability



Center Rec Complex field closures will make the existing rectangle field deficit worse by closing a large number of rectangle field hours in Lexington and will profoundly impact the operations of athletics programs in Lexington.

How can we optimize use of the fields at Lincoln Park to make sure they are available during these significant anticipated closures?





Lincoln Field Capital Projects - Updated



To maximize availability of Lincoln Fields during LHS project we propose:

- Lincoln Field #1 renovation in FY2024.
- Lincoln Field #1 and Field #3 installation of athletic lighting in FY2024
- Lincoln Field #2 renovation in FY2025 (last renovated 2016)
- Lincoln Field #3 renovation in FY2026 (last renovated 2017)



Athletic Field Renovation Considerations

In determining athletic fields, we seek to find a balance between multiple factors, and we've been working with Sustainable Lexington Committee and the Board of Health to that end. The core parameters we consider include:

- **Athletic Operations:** ex. weather resistance, surface stability/"footing", durability, hours of use
- **Environmental Health:** ex. impact on waste stream, wetlands, sustainability
- **Human Health:** ex. heavy metals, PFAS, allergens, fitness
- **Fiscal Impact:** ex. installation, maintenance, staffing, equipment, \$/hour of usage
- **Site-specific Factors:** ex. landfill
- **Town Field Inventory:** seek to reduce the existing field deficiency

Town of Lexington

Synthetic Turf Surfacing Presentation | March 1, 2023

Activitas is an independent landscape architecture and civil engineering firm that provides outdoor recreation and athletic facility consulting services for municipal, collegiate and professional sports clients throughout the United States.

- We are strictly a “client side” design firm representing only the interests of our clients.
- We do not sell, construct or otherwise profit from the installation of synthetic turf, or other playing field systems, or any associated products and equipment.
- We have been working on recreation projects for the Town of Lexington for the last 20+ years.
- Activitas did not provide the Comprehensive Study of Athletic & Outdoor Recreation Facilities, that was completed independently by Weston & Sampson.

TOWN OF LEXINGTON

MULTIPLE PROJECTS

Lexington, Massachusetts

Patrick Maguire, Mark Novak and Megan Buczynski have been working with the Lexington Recreation Department since 2000. Patrick completed a comprehensive town-wide recreational improvements implementation plan that considered new in-ground irrigation systems, fencing and backstop upgrades, 17 new tennis courts, a new running track surface, and two (2) new natural grass athletic fields.

After completing this plan, Patrick, Mark and Megan undertook an assessment and master plan for the renovation of Lincoln Park which eventually led to its award winning renovation, including three (3) new synthetic turf fields, two (2) renovated grass little league fields, a new playground and parking for 117 cars on an abandoned landfill. Since that time, Activitas has completed three (3) turf replacements at the park in addition to further upgrades at the parking lot and circulation areas.


In 2010, Megan completed a study assessing the playing field characteristics at the Center Playfields complex. She completed a drainage analysis, a site assessment, soils analysis for the five (5) fields and a layout and configuration review for the complex. Based on these results Megan developed a three-tiered approach for renovations at the complex. Using this plan, the Town implemented the strategy to upgrade all five (5) of the field areas in three (3) distinct phases: projects which Megan oversaw through construction.

Activitas completed the comprehensive town-wide accessibility study of twenty (20) outdoor athletic facilities, one (1) building and five (5) play structures. Upon completion of the study, Activitas prepared a full report for the Town to use in implementing accessibility upgrades over the next five (5) years which is the 2017 ADA Compliance Study reference in the Open Space and Recreation Plan RFP.

The following is a list of other projects completed for the Town. Each project listed below included a physical assessment of the pre-existing field/court and needs assessment with the Lexington Recreation Department prior to preparing the design for renovation. If additional information is desired, please let us know and it can be provided.

- | Lincoln Park Fields 1-3 Renovation
- | Center Tennis Courts and Clark MS Tennis Court Renovations
- | Rindge, Kinneens, Marvin and Sutherland Basketball Court Renovations
- | Center Playfields and Muzzey Fields Fencing Renovations
- | Pine Meadows Pond Dredging Project
- | ADA Improvements (based on 2016 Study)
- | Center Fields Athletic Lighting Replacement (2018)
- | Center Track and Field Renovation (2019)

ACTIVITAS

- 
- An aerial photograph of Lincoln Park, showing three large green artificial turf soccer fields arranged in a triangular pattern. A central parking lot is filled with cars. To the left of the central field is a blue playground with a small building. To the right is a baseball field. The park is surrounded by trees and a residential neighborhood in the background.
- Lincoln Park, as it is mostly now, was constructed in 2003
 - Field 1 was resurfaced in 2014
 - Field 2 was resurfaced in 2015
 - Field 3 was resurfaced in 2016
 - Surface type and materials have remained the same
 - Other upgrades include the building, the athletic lighting, the granite forest, the stony-walk, and various boardwalks and overlooks

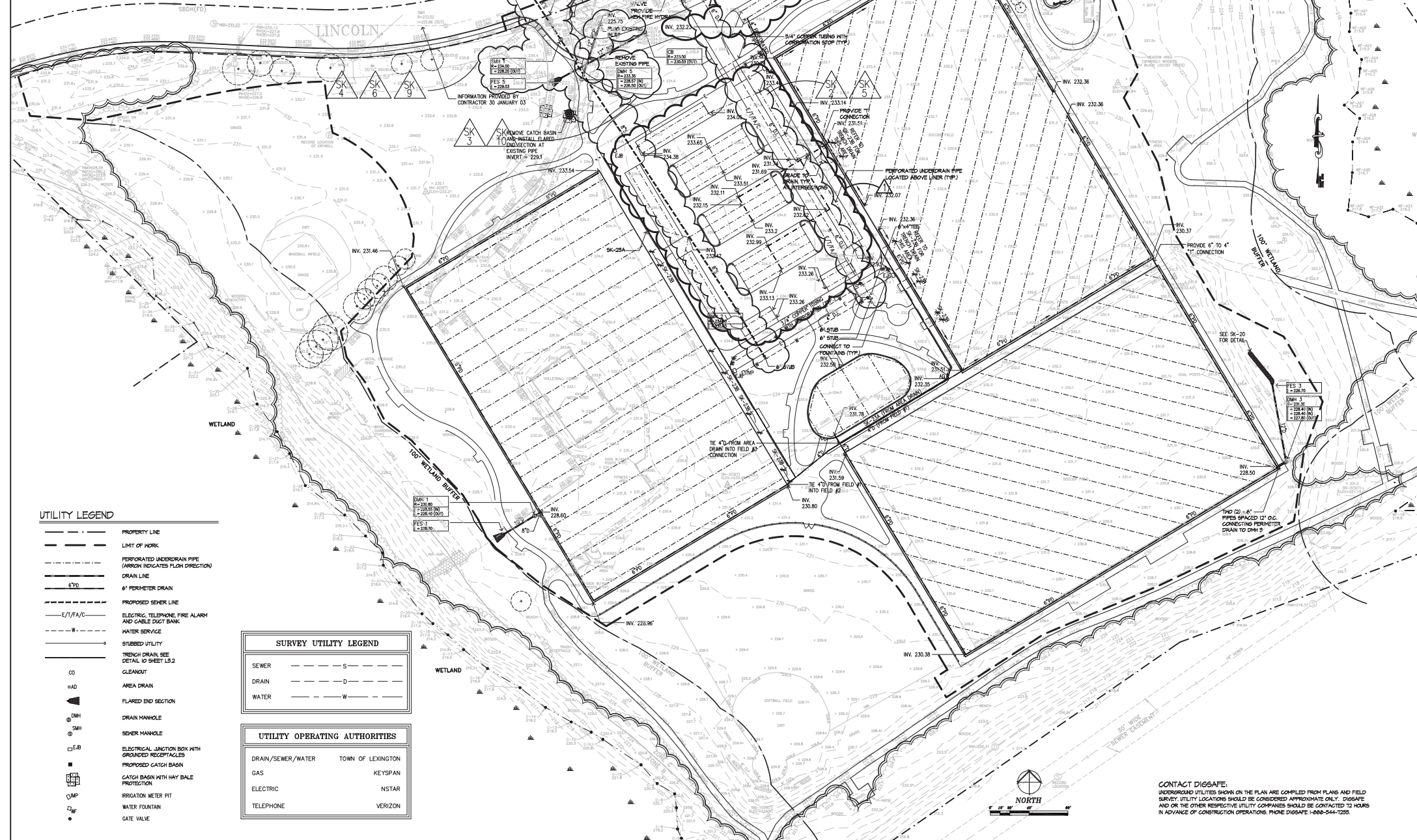
UTILITY NOTES

- EXISTING CONDITIONS INFORMATION IS REPRODUCED FROM THE SURVEY PREPARED BY HELIX ASSOCIATES LAND SURVEYORS, INC. OF WEST BREDENBURY, MA AND IS DATED 23 AUGUST 2002 AND UPDATED 21 NOVEMBER 2002.
- PRIOR TO THE START OF ANY EXCAVATION FOR THE PROJECT, BOTH ON AND OFF THE SITE, THE CONTRACTOR SHALL NOTIFY DISSEMINATE AND PROVIDED WITH A DISSEMINATE NUMBER INDICATING THAT ALL EXISTING UTILITIES HAVE BEEN LOCATED AND MARKED.
- CONTRACTOR TO ADJUST UTILITY ELEMENT HEAVY TO BE FLUSH WITH GRADE (CLEAN-OUTS, UTILITY MANHOLES, CATCH BASINS, INLETS, ETC.) THAT IS AFFECTED BY SITE WORK OR GRADE CHANGES, WHETHER SPECIFICALLY NOTED ON PLANS OR NOT.
- ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH TOWN OF LEXINGTON DEPARTMENT OF PUBLIC WORKS STANDARDS.
- ALL WORK TO BE DONE WITHIN PUBLIC RIGHT-OF-WAYS SHALL CONFORM TO THE REQUIREMENTS AND SPECIFICATIONS OF THE TOWN OF LEXINGTON AND THE MASSACHUSETTS HIGHWAY DEPARTMENT.
- THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY AND HAVE NOT BEEN INDEPENDENTLY VERIFIED BY THE OWNER OR ITS REPRESENTATIVE. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK, AND AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MAY BE OCCASIONED BY THE CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PRESERVE ALL UNDERGROUND UTILITIES.
- WHERE AN EXISTING UTILITY IS FOUND TO CONFLICT WITH THE PROPOSED WORK, THE LOCATION, ELEVATION, AND SIZE OF THE UTILITY SHALL BE ACCURATELY DETERMINED WITHOUT DELAY BY THE CONTRACTOR, AND THE INFORMATION FURNISHED TO THE ENGINEER FOR RESOLUTION OF THE CONFLICT.
- THE CONTRACTOR SHALL ALTER THE MASONRY OF THE TOP SECTION OF ALL EXISTING DRAINAGE STRUCTURES AS NECESSARY FOR CHANGES IN GRADE, AND RESET ALL WATER AND DRAINAGE FRAMES, GRATES, AND BOXES TO THE PROPOSED FINISH SURFACE GRADE.
- THE CONTRACTOR SHALL MAKE ALL ARRANGEMENTS FOR THE ALTERATION AND ADJUSTMENT OF ALL GAS, ELECTRIC, TELEPHONE, AND ANY OTHER PRIVATE UTILITIES BY THE UTILITY COMPANIES.
- CONTRACTOR SHALL MAINTAIN OR ADJUST TO NEW FINISH GRADE, AS NECESSARY, ALL UTILITY AND SITE STRUCTURES SUCH AS LIGHT POLES, MANHOLES, CATCH BASINS, HAND HOLES, WATER TAPS, GAS GATES, HYDRANTS, ETC., FROM MAINTAINED UTILITY AND SITE SYSTEMS, UNLESS OTHERWISE NOTED OR DIRECTED BY OWNER'S REPRESENTATIVE.

- ALL SEWER PIPES SHALL BE PVC PER ASTM D2004, 300R-36 AND ASTM D1784 WITH RUBBER GASKET JOINTS. REFER TO ELECTRICAL PLANS FOR SECTIONS AND DETAILS OF THE UTILITY DUCT BANK.
- AREAS OUTSIDE THE LIMITS OF PROPOSED WORK DISTURBED BY THE CONTRACTOR'S OPERATIONS SHALL BE RESTORED BY THE CONTRACTOR TO THEIR ORIGINAL CONDITION AT THE CONTRACTOR'S EXPENSE.
- REFER TO ARCHITECTURAL PLANS FOR PROPOSED LOCATION OF UTILITY SERVICE STUBS AT BUILDING.
- THE LOCATION, SIZE, DEPTH AND SPECIFICATIONS FOR CONSTRUCTION OF PRIVATE UTILITY SERVICES SHALL BE INSTALLED ACCORDING TO THE REQUIREMENTS PROVIDED BY AND APPROVED BY THE RESPECTIVE UTILITY COMPANY (GAS, TELEPHONE, ELECTRICAL, ETC.). FINAL DESIGN AND LOCATIONS AT THE BUILDING SHALL BE PROVIDED BY THE ARCHITECT. THE CONTRACTOR SHALL COORDINATE THE INSTALLATION OF THE UTILITY CONNECTIONS WITH THE RESPECTIVE COMPANIES PRIOR TO ANY UTILITY CONSTRUCTION.
- ALL GROUND LINE DUCTILE IRON JOINTS AT FITTINGS (CLASS B2) VALVES AND HYDRANT LATERALS SHALL BE MECHANICAL JOINT WITH NEOPRENE GASKETS. JOINTS AT OTHER LOCATIONS SHALL BE PUSH-ON TYPE WITH NEOPRENE OR SYNTHETIC RUBBER GASKETS. ALL WATER GATES SHALL OPEN AS PER CITY REQUIREMENTS. ALL WATER LINES SHALL HAVE A MINIMUM OF 5.0 FEET OF GROUND COVER AND A MINIMUM OF 10 FOOT SEPARATION FROM THE EDGER SYSTEM. AT WATER AND SEWER CROSSINGS, THE WATER LINE SHALL BE ENCASED IN SIX INCHES OF CONCRETE FOR A DISTANCE OF 10 FEET ON EITHER SIDE OF THE CROSSING.
- PROTECT AND MAINTAIN EXISTING ON-SITE DRAINAGE STRUCTURES AND PIPES UNLESS OTHERWISE NOTED.

PROJECT BENCHMARK "B":
NORTHWEST CORNER OF S.B. 11
ELEVATION=233.73 (N.G.V.D. OF 1929)

PROJECT BENCHMARK "B":
IS A RAILROAD SPIKE SET 1" ABOVE GRADE
IN SOUTH SIDE OF UTILITY POLE #18.
ELEVATION=238.42 (N.G.V.D. OF 1929)



UTILITY LEGEND

- PROPERTY LINE
- LIMIT OF WORK
- PERFORATED UNDERDRAIN PIPE (ARROW INDICATES FLOW DIRECTION)
- DRAIN LINE
- 6" PD
- 6" PERIMETER DRAIN
- PROPOSED SEWER LINE
- ELECTRIC, TELEPHONE, FIRE ALARM AND CABLE DUCT BANK
- WATER SERVICE
- STUBBED UTILITY
- TRENCH DRAIN, SEE DETAIL 10 SHEET L3.2
- CLEANOUT
- AREA DRAIN
- FLARED END SECTION
- DRAIN MANHOLE
- SEWER MANHOLE
- ELECTRICAL JUNCTION BOX WITH GROUNDING RECEPTACLES
- PROPOSED CATCH BASIN
- CATCH BASIN WITH HAY BALE PROTECTION
- IRRIGATION METER PIT
- WATER FOUNTAIN
- GATE VALVE

SURVEY UTILITY LEGEND

SEWER	---	S
DRAIN	---	D
WATER	---	W

UTILITY OPERATING AUTHORITIES

DRAIN/SEWER/WATER	TOWN OF LEXINGTON
GAS	KEYSPAN
ELECTRIC	NSTAR
TELEPHONE	VERIZON



77 NORTH WASHINGTON STREET
LEXINGTON, MA 02174
PH: 781.862.0000 FAX: 781.862.0000



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PH: 781.862.0000 FAX: 781.862.0000

Lincoln Park
Lexington, Massachusetts

ATHLETIC FIELDS AND
PARK IMPROVEMENTS PROJECT

REV.	DATE	BY	CHK.
1	2/26/03	JSC	RYM
2	5/5/03	JSC	RYM

DEP. REVISED DESIGN SET
May 5, 2003
UTILITY PLAN

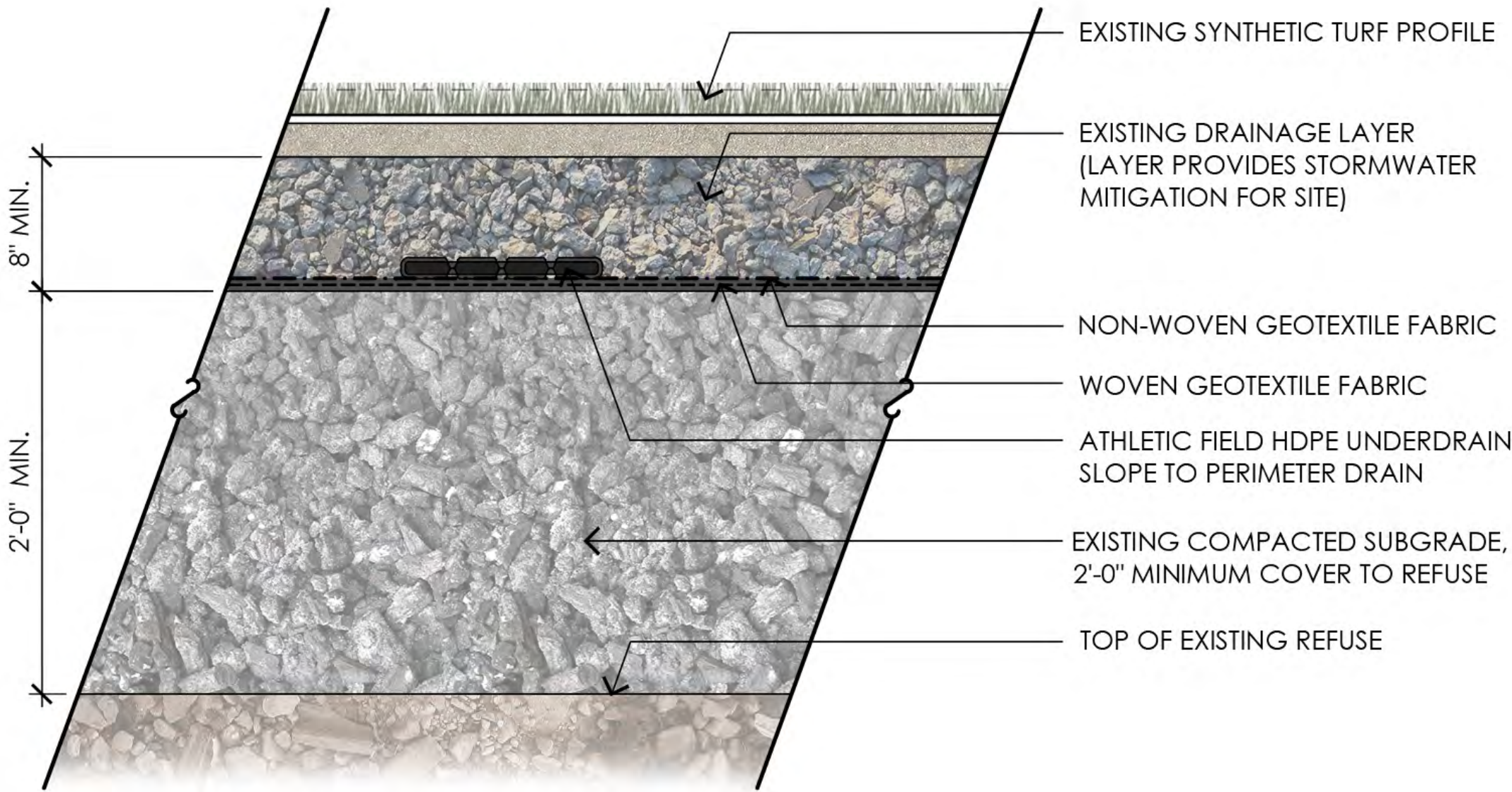
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DRAWN:	MEP
CHECKED:	WZ & DPM
SHEET NO:	

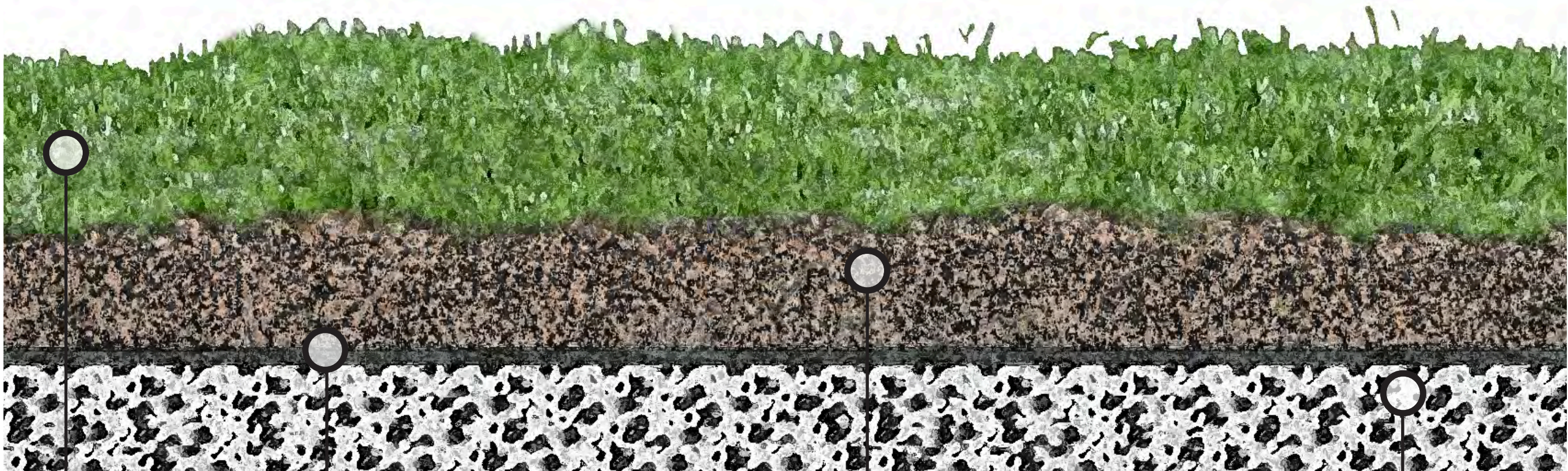
L3.1

CONTACT DIGSAFE.
UNDERGROUND UTILITIES SHOWN ON THE PLAN ARE COMPILED FROM PLANS AND FIELD SURVEY. UTILITY LOCATIONS SHOULD BE CONSIDERED APPROXIMATE ONLY. DIGSAFE AND OR THE OTHER RESPECTIVE UTILITY COMPANIES SHOULD BE CONTACTED 12 HOURS IN ADVANCE OF CONSTRUCTION OPERATIONS. PHONE DIGSAFE 1-888-544-7225.

Town of Lexington

Synthetic Turf Surfacing Presentation | March 1, 2023





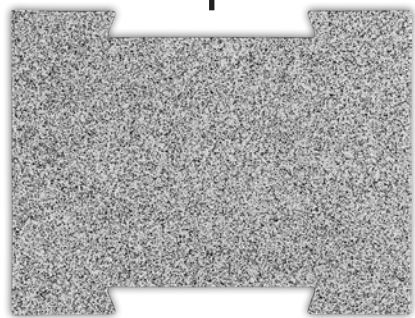
Fiber Type



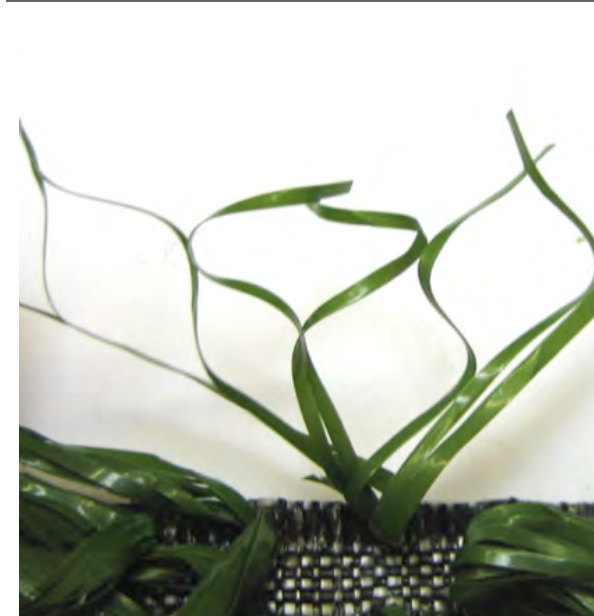
Backing



Infill Materials



Resilient Underlayment



Traditional Slit Film

- Extruded tape-like flat strands that are sliced (slit) forming a honeycomb-like fiber
- Once the turf system is installed, the tops of the strands break apart (or 'filibrate') creating a more natural looking surface
- Holds up to high use activity better than monofilament
- Tends to provide a faster ball roll and less infill splash.



Traditional Polyethylene & Urethane Backing

- Polyethylene primary backing with polyurethane secondary backing
- Drainage through carpet by punching holes through the backing
- Limited recyclability of the carpet because of the mixture of PE and PU for the backing



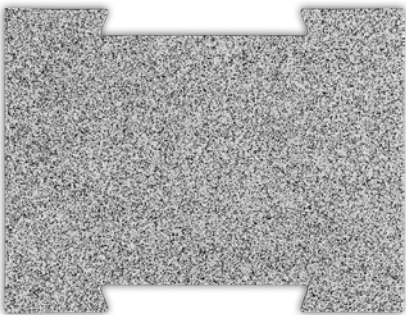
Infill Material - Silica Sand

- Natural and Consistent Material
- Industry-wide Acceptance with All Turf and Infill Combinations
- Without Proper Maintenance Silica Sand Compacts Over Time with Heavy Use



Infill Material - Crumb Rubber / Alternative Material

- Made from Recycled Tires
- Creates Cushioned Feel to the Turf
- Least Expensive Infill
- As process continues infill materials will continue to be reviewed by the Working Group



Resilient Underlayment

- Expanded polypropylene made of 30% recycled materials
- Porous material allowing vertical drainage
- Maintains impact safety of system while not compromising playability

Town of Lexington

Synthetic Turf Surfacing Presentation | March 1, 2023

Typical Seasonal Synthetic Turf Maintenance

- Field grooming before each season and 1-2 times during season as needed
- Debris removal, monthly or as needed
- Disinfection application 1x per year - completed by a subcontractor
- Infill releveling - as needed, not typically yearly, completed by a subcontractor
- Line striping - typically before each season then as needed for programming
- Recreation Committee Policy is no snow removal



Town of Lexington

Synthetic Turf Surfacing Presentation | March 1, 2023



ONE TURF CONCEPT

A multi-sport consensus on long pile artificial turf community fields



March 2017

FIFA, FIH and World Rugby have invested large amounts of resources in developing long pile artificial turf requirements that reflect best practice in the areas of player welfare, performance, sustainability and longevity. All three federations recognise the benefit of artificial turf at all levels of their respective sports and, while each has unique playing characteristics, collectively support the development of, and investment in, multi-use community fields. While short-pile products are the preferred surface for hockey, the FIH recognises that long pile (3G) surfaces can also aid hockey development where the national association permits it.

It is the intention of this document to better inform users of the benefits of testing and continuing to test against these requirements.

With this in mind, FIFA, FIH and World Rugby have combined resources to identify best practice for multi-use long pile community based fields and provide information to facility owners, managers and investors in ensuring that their fields achieve the highest possible standards. Some sports have, in addition to those listed here, additional requirements for elite level fields, details of which can be sourced from the individual sports.

The organisations from within the industry who have offered support to this initiative indicates the importance of trying to ensure better quality artificial turf products continue to be installed globally.

It should be noted that each federation has their own certification process and that application of these best practices does not guarantee that certification by one or any of the federations will be achieved. Other sports may also have additional requirements which must be met before they can be played on the field.

The information contained below is in consideration of what a multi-use long pile community field should achieve. It is not intended to be used for certification purposes, nor is it sport specific but it is considered that, if complied with, the field will be suitable for general use.

This document is separated into three parts:

- Basic requirements for an existing field
- Standard considerations for future fields
- Identification of sport specific requirements

For all of the tests listed below federations stress the importance of having the testing completed by a knowledgeable and accredited test institute. Many federations provide accreditation processes for such test institutes which incorporates a rigorous round robin testing process with regular re-accreditation required. Achievement of certification of fields for each of these federations is only possible through testing by one of these accredited test institutes.

One Turf Concept

One Turf Concept

Basic Requirements for existing fields

While each of the three federations recommend that the full battery of tests required by their certification processes are met, existing fields may not be capable of achieving this. It is important to note that World Rugby require all fields intended to be used for rugby to be tested to and to comply fully with Regulation 22 requirements before any contact rugby, whether training or matches, takes place on the field.

With this in mind, facility owners should content themselves that the basic performance requirements listed below are met by their fields. The data indicates the levels for each parameter achieved by good quality natural turf surfaces for all sports, all of which have been extensively tested to determine these requirements. Statistical information available has indicated that there is no difference in injury rates between those occurring on good quality natural turf surfaces and those occurring on compliant artificial turf surfaces.

A brief explanation of the risks of each parameter being outside the recommended limits is provided in each case.

Parameter	Test Method	Minimum Value	Maximum Value
Shock Absorption	AAA Version (FIFA Method)	55%	70%
Vertical Deformation		5mm	11mm
Rotational Resistance	EN 15301-1 (football studs)	25Nm	50Nm
Impact Attenuation (HIC)	EN 1177	1.3m	-
Ball Roll (large ball)	FIFA Method	-	12m
Vertical Ball Rebound (large ball)	EN 12235 (absolute)	0.6m	1.0m
Evenness (Surface Regularity)	EN 13606 (3m straight edge)	-	10mm
Slope	Surveyor's Level		1%

Parameter	Too Low	Too High
Shock Absorption	The surface will feel too hard and result in an increased risk of injury to players from compaction of the meniscus in the knee joints and the spinal column.	The surface will feel heavy to the players and will sap their energy tiring them out quicker.
Vertical Deformation	The field does not have enough compressibility and will feel hard to run on resulting in potential joint and muscle soreness.	The field will deform too much under the player which may result in overstretching of ligaments.
Rotational Resistance	The players are more likely to slip and have less confidence in their foot holding. It makes change of direction much more difficult and slippage can result in over extension injuries.	The natural slippage that is expected is reduced meaning that the likelihood of excessive grip between the boot and the surface increases the risk of potential joint injuries, especially ankle and knee.
Impact Attenuation (HIC)*	The likelihood of serious injury occurring as a result of a player hitting their head on the surface is increased.	There is no real risk to having a high HIC, however to achieve higher values, the likelihood of other requirements not achieving their required levels is increased.
Ball Roll (large ball)	While Ball Roll is a specific playability requirement for football and hockey, the use of Ball Roll as a tool to identify the condition and orientation of the fibres is recognised by all sports. It is included here as a maintenance indication tool and also an on-field guide to the potential for friction burns and abrasion to occur. A high Ball Roll indicates that the fibres may be lying flat and that this risk is increased.	
Vertical Ball Rebound (large ball)	The ball will bounce less than is expected resulting in a deadening of the ball.	The surface will make the ball bounce an unusually high amount.

These parameters should not be taken independently. A field's performance can only be truly ascertained by completion of all of these parameters and the potential effect that changing one could have on the others considered.

Town of Lexington

Synthetic Turf Surfacing Presentation | March 1, 2023

Draft Language that will be included within the synthetic turf specifications section. This language has been updated since the last turf replacement project in Town (Lincoln 3) and since the new field at Center Track.		
Town of Lexington endeavors to keep the existing infilled synthetic turf system out of the waste stream. The Town further endeavors to reuse and/or recycle the infill and synthetic turf carpet.		
WASTE MANAGEMENT GOALS		
A.	The waste management goal to be achieved for this project is to reuse the existing field's sand and rubber infill to the extent practicable and to recycle or repurpose the synthetic turf carpet and fibers.	
1.	Reduce Waste: This project shall generate the least amount of waste feasible and methods shall be used to minimize wasted due to error, poor planning, breakage, mishandling, contamination, or similar factors.	
2.	Reuse: The Contractor shall reuse materials to the greatest extent possible. Salvage reusable materials for resale, for reuse on this project, or for storage for use on future projects. Return reusable items (ex: pallets, tubing or unused products) to the material suppliers.	
3.	Recycle: As many of the waste materials not able to be eliminated in the first place or salvaged for reuse shall be recycled. Waste disposal in landfills shall be minimized to the greatest extent possible.	
REMOVAL AND RECYCLING OF EXISTING SYNTHETIC TURF CARPET AND INFILL		
A.	Contractor shall cut, roll and temporarily store pieces of turf carpet and infill as indicated on the Drawings to be delivered to the Owner by others.	
B.	To the extent practicable, all sand and rubber infill shall be removed with machinery that can simultaneously remove and convey the infill from the synthetic turf carpet into supersacks to be reused or recycled. If the turf installer does not reuse the infill in the new synthetic turf field system, the turf installer shall provide in writing the chain of custody for the sand and rubber, certifying that the infill will be recycled/repurposed and eventually used on another synthetic turf field for infill or other applications which do not result in the landfilling of materials. This certification shall be provided to the Owner's Representative and Town of Lexington as a condition for payment.	
C.	The existing synthetic turf carpet and fiber shall be removed and recycled. Disposal of the synthetic turf carpet and fiber in a landfill will not be permitted. The turf installer shall provide in writing the chain of custody for the carpet and fiber, certifying that the carpet and fiber will be recycled/repurposed. This certification shall be provided to the Owner's Representative and Town of Lexington as a condition of payment.	
SUBMITTALS		
A.	Cut Sheets for all materials required under this Section including third party ASTM certified lab reports.	
B.	Material Safety Data Sheets (MSDS) for all materials required under this Section.	
C.	HEAVY METALS: The Infilled Synthetic Turf Vendor shall submit a signed letter, on company letterhead, stating the company's specific manufacturing and procurement practices that address Health and Human Safety concerns. The letter shall certify, through the independent testing of all Infilled Synthetic Turf System components installed as part of the Project, that their system's lead and other heavy metal content complies with the United	
	States Consumer Product Safety Commission's (CPSC) most stringent requirement for lead content in children's toys (below 100 ppm), is safe for the environment and for use by people of all ages. Copies of the testing reports shall also be provided in conjunction with the certification. Installation of the field shall not commence until the written certification is received. Adjustments to the project schedule to accommodate testing laboratory schedules will not be granted.	
D.	PFAS: The Infilled Synthetic Turf Vendor shall submit a signed letter, on company letterhead, stating that the Vendor and their suppliers do not use PFAS (as defined in EPA Method 537 and California Proposition 65) in or as part of their manufacturing process for their turf fibers, primary backings, and urethane coatings or the assembly of any components of the system or system as a whole. PFAS must be non-detectable at analytical detection limits that are suitable to meet state regulatory standards for solids as defined below. Alternatively, PFAS must be non-detectable at analytical detection limits that are suitable to meet state regulatory standards for liquid as defined below using a leaching test (e.g., EPA Method 1312). If an Infilled Synthetic Turf Vendor is unable to provide this information, they will be rejected for not meeting this requirement.	
	Required detection limits - solids: PFDA: 0.03 ug/kg PFHpA: 0.05 ug/kg PFHxS: 0.03 ug/kg PFNA: 0.03 ug/kg PFOs: 0.2 ug/kg PFOA: 0.07 ug/kg	
	Required detection limits – liquid: PFDA: 0.003 ug/L PFHpA: 0.003 ug/L PFHxS: 0.003 ug/L PFNA: 0.003 ug/L PFOs: 0.003 ug/L PFOA: 0.003 ug/L	
E.	Letter of certification that the existing synthetic turf carpet has been recycled/repurposed and all associated Chain of Custody documentation.	
INFILL MATERIALS		
A.	The Infilled Synthetic Turf Vendor shall provide a signed letter on company letterhead stating that their system (with the resilient underlayment) using the infill mix ratio below will meet performance requirements set forth in this specification. In the event that the Vendor does not believe they can meet the performance criteria within this specification, the Vendor shall provide a request to the Landscape Architect/Civil Engineer prior to the date questions are due with a requested alternative mix ratio.	
B.	The existing system has an average of 1" of infill assumed to be a 60:40 sand:rubber by weight mixture. The Vendor shall provide additional infill materials as needed to uniformly fill the carpet to a depth which leaves no more than 1/2" of exposed pile after settlement, and consists of a homogeneous non-compacting mixture of silica sand and resilient granules meeting the following criteria:	
1.	The sand:rubber content shall be 60%:40% by weight +/-2%.	
2.	Silica sand shall meet the following criteria:	
a.	Infill sand shall be high quality clean grains of rounded silica sand (SiO2) equivalent to:	
(i)	Granusil 4095 Unimin Corporation, New Cannan, CT 203-966-8880 20/40 HC	
(ii)	Oglebay Norton, Brady, TX 915-597-0721 20/40 Oil Frac	
(iii)	US Silica, Ottawa, IL 800-243-7500	
b.	Angular or sub-angular particles will not be accepted. Sand shall have 100% passing the #16 sieve, no more than 80% passing the #30 sieve and no more than 0.5% passing the #50 sieve per ASTM E-11 and also meet the following requirements:	
(i)	Hardness	7.0 Mohs
(ii)	Moisture Content	<0.1% per ASTM C-566
(iii)	Specific Gravity	2.65 g/cm3 per ASTM C-128
(iv)	Aerated Bulk Density	92-102 lb/ft2 per ASTM C-29
(v)	Compacted Bulk Density	98-110 lb.ft2 per ASTM C-29
3.	Resilient granules shall meet the following criteria:	
a.	SBR Rubber - Granules shall be processed recycled rubber derived from <u>passenger tires</u> . Rubber shall contain no dust or contaminants and shall work to hold the infill sand in suspension. Color to be black.	
PERFORMANCE TESTING ON FINAL SURFACE		
A.	GMAX: The Infilled Synthetic Turf System Vendor shall have G-Max testing performed by an approved and certified Independent Testing Company prior to requesting Substantial Completion. Testing shall consist of shock attenuation per ASTM F-355-A and F-1936 current edition and shall include the depth of infill as the test location as well as the temperature on the day of testing. The Owner and Landscape Architect/Civil Engineer shall be provided with copies of all testing.	
B.	HIC Testing: Testing shall be in accordance with EN-1177 and critical fall height shall not be less than 1.4-meters.	
C.	Artificial Athlete: Testing shall be in accordance with EN-14808/14809 and shall be completed in 6 locations over the field area. Vertical deformation shall be 4-11 mm, shock absorption shall be 55-70%, and energy restitution 25-50%.	
D.	Infill Depth: Infill depth testing by means of an infill depth gauge capable of measuring 0-2 inches per ASTM WK51663 using a Constant Ground Pressure 3-Prong Gauge. A minimum of 40 test locations shall be taken at random and documented in the test results provided to the Landscape Architect / Civil Engineer and Owner.	
1.	If the results of the depth gauge show the infill height to be on average lower than the depth specified, additional infill will be added to meet the specification and the field will be re-tested to show compliance.	

Town of Lexington

Synthetic Turf Surfacing Presentation | March 1, 2023



delivered via email
mbatlite@lexingtonma.gov dpinsonneault@lexingtonma.gov

28 January 2020

Lexington Recreation Committee
c/o Ms. Melissa Batlite and
Director of Recreation and Community Programs
Town of Lexington
39 Marrett Road
Lexington, MA 02420

Mr. David Pinsonneault
Director of Public Works
Town of Lexington
201 Bedford Street
Lexington, MA 02420

Re: Town of Lexington Center Track and Field Renovations
Field Surface Testing Results

Dear **Ms. Batlite & Mr. Pinsonneault:**

Aligning with the testing completed on the fields at Lincoln Fields, following the installation of the turf at the Center Playfields Track and Field, Activitas sent turf and infill samples to LaboSport to test for heavy metals and PAHs. The following tests were completed:

- Heavy Metals (lixivation) exceeding the DIN 18035 standard - meaning chemicals' ability to leach out into water/liquid
- Heavy Metals (migration) exceeding the EN 71-3 Standard for Safety of Toys - this is the European standard which is more stringent than the ASTM standard - basically testing if someone eats the system components, how much of the chemicals can come out (bio-available for the body to absorb).
- PAHs (migration) exceeding the EPA standards.
- Lead exceeding the ASTM F2765 Standard - this is for testing of the fibers and determining the lead content in the fibers.

The test results showed that none of the heavy metals or PAHs within the system components are bio-available to a person or could leach into water at any concentration that is of concern. In addition, no lead was found within the fiber components.

Respectfully:

ACTIVITAS

Meg Buczynski, PE
Principal Civil Engineer

Attachments: LaboSport Test Report dated January 21st, 2020

Toxicological analysis on a synthetic turf system



INFORMATION

Product description	Synthetic turf carpet filled with rubber infill			
Product name	Unknown			
Sample number	Performance infill (rubber): US00335		Synthetic turf carpet: US00336	
Date of reception	November 11 th , 2019			
Date of tests	December 2019 - January 2020			
Temperature	MIN	70°F (21°C)	Max	73°F (23°C)
Humidity	MIN	48 %RH	Max	55 %RH

RESULTS

Toxicological analysis of Heavy Metals – DIN 18035-7 (lixivation):

Parameters	Units	Test method	Results	Requirements	Pass/Fail
Lead	mg/L	DIN 18035-7	< 0.005	< 0.025	Pass
Cadmium	mg/L	DIN 18035-7	< 0.001	< 0.005	Pass
Total Chromium	mg/L	DIN 18035-7	< 0.002	< 0.05	Pass
Tin	mg/L	DIN 18035-7	< 0.005	< 0.040	Pass
Chromium VI	mg/L	DIN 18035-7	< 0.008	< 0.008	Pass
Mercury	mg/L	DIN 18035-7	< 0.015	< 1	Pass
Zinc	mg/L	DIN 18035-7	0.43	< 0.5	Pass
COD	mg/L	DIN 18035-7	20.4	< 50	Pass

Toxicological analysis of Heavy Metals – EN 71-3 (migration):

Element	Units	Test method	Results	Requirements (Material of Category III)	Pass/Fail
Aluminium	mg/kg DW	EN 71-3	13.5	< 70 000	Pass
Antimony	mg/kg DW	EN 71-3	< 0.5	< 560	Pass
Arsenic	mg/kg DW	EN 71-3	< 0.05	< 47	Pass
Barium	mg/kg DW	EN 71-3	0.85	< 18 750	Pass
Boron	mg/kg DW	EN 71-3	< 0.5	< 15 000	Pass
Cadmium	mg/kg DW	EN 71-3	< 0.25	< 17	Pass
Cobalt	mg/kg DW	EN 71-3	< 0.5	< 130	Pass
Copper	mg/kg DW	EN 71-3	4.5	< 7 700	Pass
Lead	mg/kg DW	EN 71-3	< 2.5	< 23	Pass
Manganese	mg/kg DW	EN 71-3	< 1	< 15 000	Pass
Mercury	mg/kg DW	EN 71-3	< 0.005	< 94	Pass
Nickel	mg/kg DW	EN 71-3	< 0.5	< 930	Pass
Selenium	mg/kg DW	EN 71-3	< 0.25	< 460	Pass
Strontium	mg/kg DW	EN 71-3	< 0.5	< 56 000	Pass
Tin	mg/kg DW	EN 71-3	< 2.5	< 180 000	Pass
Zinc	mg/kg DW	EN 71-3	153	< 46 000	Pass
Chromium III	mg/kg DW	EN 71-3	< 0.5	< 460	Pass
Chromium VI	mg/kg DW	EN 71-3	< 0.05	< 0.2	Pass

Report number: R19138US-A1
Date: January 21st, 2020

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Toxicological Analysis on a Synthetic Turf System



Toxicological analysis of PAH:

Element	Units	Test method	Results
Benzo (a) pyrene	mg/kg DW	US EPA 8270	1.90
Benzo (e) pyrene	mg/kg DW	US EPA 8270	1.40
Benzo (a) anthracene	mg/kg DW	US EPA 8270	8.40
Chrysene	mg/kg DW	US EPA 8270	4.10
Benzo (j+b) fluoranthene	mg/kg DW	US EPA 8270	4.50
Benzo (k) fluoranthene	mg/kg DW	US EPA 8270	0.82
Dibenzo (a,h) anthracene	mg/kg DW	US EPA 8270	0.48
Indeno (1,2,3-cd) pyrene	mg/kg DW	US EPA 8270	0.79
Benzo (ghi) perylene	mg/kg DW	US EPA 8270	3.30
Naphtalene	mg/kg DW	US EPA 8270	0.76
Acenaphtene	mg/kg DW	US EPA 8270	0.26
Acenaphtylene	mg/kg DW	US EPA 8270	0.55
Anthracene	mg/kg DW	US EPA 8270	2.20
Fluoranthene	mg/kg DW	US EPA 8270	11
Fluorene	mg/kg DW	US EPA 8270	1.30
Phenanthrene	mg/kg DW	US EPA 8270	8.70
Pyrene	mg/kg DW	US EPA 8270	22
Total of 17 PAHs			72.4 mg/kg DW

Fiber lead content:

Element	Units	Test method	Results
Fiber lead content	ppm	ASTM F2765	< 0.25ppm

REPORTED BY


Loïc Schuffenecker
(Laboratory Technician) - Writer


Thomas Amadei, T.P.
(Laboratory Manager) - Approver

Report number: R19138US-A1
Date: January 21st, 2020

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An aerial photograph of a school sports complex. In the foreground, there are three large green soccer fields with white markings. To the left of the soccer fields is a baseball field with a brown infield. In the background, there are several buildings, including a large white water tower, and a dense forest of trees. The text "Human Health and Safety / Environmental Common Questions" is overlaid in the center of the image.

Human Health and Safety / Environmental Common Questions

ACTIVITAS

Safety of Turf

- Heavy metals and polyaromatic hydrocarbons (PAHs)
 - Crumb rubber infill
- Per- and poly-fluoroalkyl substances (PFAS)
 - Turf carpeting, backing, shock pad
- Heat
 - Turf system
- Questions that we resolved:
 - *Would contact with PAHs, metals, or PFAS in synthetic turf be considered safe?*
 - *Would substances in synthetic turf contaminate groundwater?*
 - *Is a synthetic turf field a ‘heat island’?*

Method of Evaluation

- Over 100 peer-reviewed studies over the past two decades: none have drawn an association between adverse health effects and crumb rubber
- We focused recent studies (2014 – 2022) specifically evaluating whether substances in crumb rubber or turf systems could pose a health risk that would be deemed unsafe, including:
 - comprehensive study by the U.S. Environmental Protection Agency
 - comprehensive studies performed for synthetic turf systems for Martha's Vineyard (MA) high school and the city of Portsmouth (NH)

Method of Evaluation (continued)

- Evaluated safety using the process of Risk Assessment
 - *Are chemicals present in synthetic turf systems?*
 - *If so, how much chemical in synthetic turf could people be exposed to?*
 - *Would that exposure be considered safe?*
- Same process that is used by Massachusetts Department of Environmental Protection (MassDEP) and the U.S. Environmental Protection Agency (EPA) to determine if chemicals in soil and groundwater are safe

Heavy Metals and PAHs

- Overall conclusions - *PAHs and metals in turf are safe*:
 - PAHs and metals in crumb rubber, turf carpeting, and bonding agents and do not come out at concentrations that could be harmful (low bioavailability)
 - Even without accounting for low bioavailability, concentrations are generally below levels that MassDEP and EPA consider safe for soil in a backyard
 - Concentrations in many cases are similar to normal background levels in soil
 - Conclusion backed by Mass Department of Health

PFAS

- Overall conclusions – *PFAS are not a concern in synthetic turf:*
 - Most PFAS compounds tested for were not detectable in synthetic turf from the manufacturer
 - No PFAS compounds were detected at concentrations above MassDEP standards
 - No other PFAS compounds were detected at concentrations that would cause a contact or leaching concern to groundwater or surface water
 - PFAS concentrations that typically occur in soil as a background condition were higher than PFAS concentrations in synthetic turf from the manufacturer

Heat

- Overall conclusions – *Synthetic turf is not a Heat Island:*
 - Synthetic turf does not ‘hold heat’ - returns to same temperature as natural turf with loss of daytime heating
 - As compared to asphalt, brick, and masonry, synthetic turf cools much quicker with loss of daytime heating



Summary



- The existing deficit in available field hours *and* the anticipated exacerbation of that deficit during a LHS building project highlight the need to optimize management of the synthetic fields at Lincoln Park.
- The timely renovation of the synthetic turf at the fields (Field #1 in FY2024) is critical to avoid compounding the effect of the LHS building-associated closures.
- The replacement “in kind” of Lincoln Field with a synthetic turf system that is certified PFAS-free and meets all federal and state regulations represents a reasonable balance of the many competing factors.



Summary

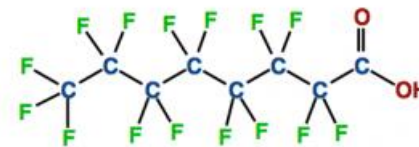


Thank you for joining us.

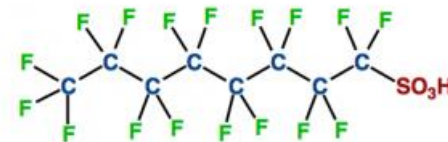
We look forward to your questions and feedback both now and by sending email to recdept@lexingtonma.gov or recreationcmte@lexingtonma.gov

What are PFAS?

- Per- and Polyfluoroalkyl Substances (EPA Definition)
- PFAS are partial to fully fluorinated, organic compounds that have been produced in the largest amounts within the United States
- PFAS are the family of synthetic chemicals that include long chains of carbon and fluorine
- Up to 5,000 different PFAS, about 2 dozen “common” PFAS can be tested for
- Have unique lipid- and water-repellent characteristics, and are used as surface-active agents in various high-temperature applications and as a coating on surfaces that contact with strong acids or bases
- Found to be Ubiquitous in the Environmental across the Globe



PFOA - perfluorooctanoic acid



PFOS - perfluorooctanesulfonic acid

Historic PFAS Uses

- Used in fire fighting and odor control foams, Aqueous Film-Forming Foam (AFFF)
- Also used in industrial and commercial products including:
 - Textiles and leather products (Gore-Tex, Polartec)
 - Metal plating
 - Stain-resistant fabric
 - Photographic industry/photolithography
 - Semi-conductors
 - Paper and packaging (fast food wrappers)
 - Coating additives (Teflon)
 - Cleaning products
 - Pesticides



PFAS of Concern are Ubiquitous in our Environment

Mass Rainwater Can Be A Source Of PFAS

Individual PFAS levels of 1.8 to 3.5 ppt.

Total PFAS up to 8.5 ppt

Other studies report up to 1,000 ppt

PFAS Background in Vermont Soils

PFAS found in every sample collected.

Urban to Rural to Forested

540 to 35,000 ppb

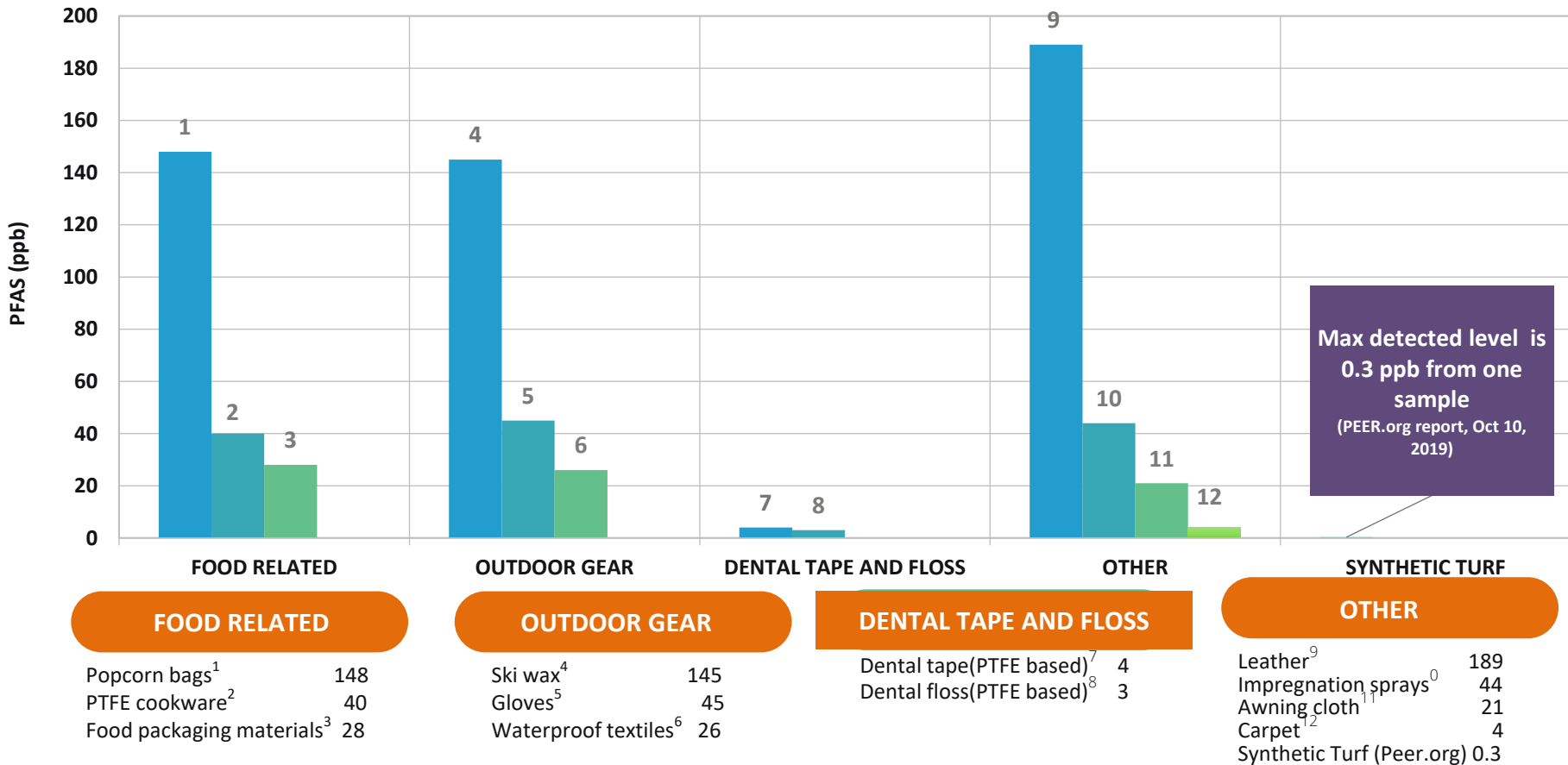
PFAS in Urine

11 ppt



Turf Contains PFAS

- PVDF-HFP
 - Processing aid
 - A large, not bioavailable PFAS
 - Used in stints, sutures, meshes
 - Not one of the Regulated Compounds by EPA or any State



RISK = CONCENTRATION & EXPOSURE

Reference Dose = 0.00002 mg/Kg body weight per day
(includes a safety factor of 300 for “interspecies” differences)

Drinking Water Limit

$$\text{RFD} * 3\text{L water per day} * 70 \text{ years} * 0.2$$

(20% of PFAS exposure from water)

4,053 gal of water with DWL concentration to increase risk of getting a disease from PFAS by 1 in 1,000,000

- 12 yrs of play on field, 3 times a week would need to drink 2 gallons of field water per practice

Recent Synthetic Turf Testing Results

Martha's Vineyard Study

The concentrations of PFAS observed by all of the analyses performed on synthetic turf components are *"...consistent with background concentrations in natural soil or at concentrations well below referenced risk-based standards..."* (TetraTech, February 26, 2021)

3rd Party review concluded *"...Based on the results presented...PFAS...have been detected in the field components at concentrations consistent with background and/or below the applicable comparison values. We agree with the report conclusion that the overall risk to human health through a direct contact exposure with the field components is de minimis."* (Horsley Whitten Group, March 1, 2021)

Portsmouth NH

This study concluded: *"Based on this evaluation, the detection of very low levels of a limited number of PFAS in the synthetic turf components does not represent a human health risk to those using the synthetic turf ballfields."* (TRC, June 7, 2022)

Based upon the information we have reviewed to date, the trace concentrations of PFAS identified in synthetic turf components which we have tested or reviewed pose No Significant Health Risk to field users or the environment.

OUR SPECIFICATIONS

To support a condition of No Significant Health Risk related to PFAS, our specifications for synthetic turf products are updated frequently to stay current with the Best Available Technology and PFAS science and require:


- 1) Certification from manufacturer that each component meets the current California Prop 65 and European REACH standards.
- 2) Each component to be installed (same batch as will be placed at our project) must be tested for the presence of PFAS. The testing results must be provided under notarized letter for review prior to approval for installation and indicate the following:
 - a. all products provided for incorporation into the synthetic turf system do not contain PFAS as quantified by EPA Method 533 Modified, EPA Method 537 Modified with isotope dilution, DoD QSM 5.4 Table B-15 or Engineer approved equivalent. The PFAS testing method utilized must report at least 29 PFAS compounds including the PFAS regulated by the STATE, and on the most current European Union REACH and California Proposition 65 compound lists.

Artificial Turf Study Committee - Communication

Susan D. Chapnick <s.chapnick@comcast.net>

Fri 12/15/2023 11:31 AM

To:BOH <BOH@town.arlington.ma.us>

 2 attachments (785 KB)

Chapnick_Artificial Turf Study Committee_communication_15Dec2023.pdf; TURI_Factsheet.Artificial_Turf.September2020.pdf.pdf;

CAUTION: This email originated from outside your organization. Exercise caution when opening attachments or clicking links, especially from unknown senders.

Natasha,

Please accept this public communication to the Artificial Turf Study Committee. I am forwarding this communication as an Arlington resident, environmental scientist, and conservation commissioner, but these communications/statements are my own and not a representation of the full commission.

I have attached 2 documents and provide a website link for the 3rd, as described below.

1. Chapnick_Artificial Turf Committee_communication_15Dec2023: My statement with references on the weight-of-evidence for harm of artificial turf fields to the environment, with special emphasis on wetland resources and wildlife habitat.

2. TURI_Factsheet.Artificial_Turf.September2020: Fact sheet from a State-established institute, TURI, which includes extensive references from government sources, peer-reviewed papers, and from other public media.

https://www.turi.org/content/download/13271/203906/file/Factsheet.Artificial_Turf.September2020.pdf
[.pdf](#)

Established by the Commonwealth of Massachusetts in 1989, the Toxics Use Reduction Institute (TURI) is an independent government agency with a mandate to help protect workers, communities and the environment from toxic chemicals and pollution. Working in close collaboration with businesses of all sizes, as well as government agencies, local communities and international organizations, TURI helps identify actions companies and communities can take to protect workers and public health.

This fact sheet summarizes information on Artificial Turf and chemicals of concern, Artificial turf and heat stress, Injuries (artificial turf compared to natural grass), environmental concerns, and cost comparisons of installation and maintenance of artificial turf with natural grass. References and links are provided for further information and so that the original reference materials can be accessed.

3. Massachusetts Healthy Soils initiative from 2022-2023.

<https://www.mass.gov/doc/healthy-soils-action-plan-2023/download>

[This document was too large to attach to an email - please use the link to download the document - all quotes below are from this document.]

"The purpose of the Massachusetts Healthy Soils Action Plan is to provide evidence-based recommendations that help people better protect, restore, and manage soils of five major land covers: Forests, Wetlands, Agriculture, Recreational and Ornamental Landscapes, and Impervious and Urbanized Lands."

"Carbon content is one of the few universally agreed-upon indicators of soil health." The carbon in organic matter in soil is referred to as "Soil Organic Carbon" or "SOC". When soils are disturbed, removed, or covered by an inert surface, the carbon is released and the soil function of being able to sequester carbon is lost. Therefore, converting land cover from soil / natural grass to artificial turf would release sequestered carbon and not be consistent with preservation of soils as a climate change resilience strategy.

There are many other government and peer-reviewed documents, as well as statements by independent scientists and doctors - but I hope that these documents will give a foundation to understanding the potential harm of artificial turf fields on the environment and harm in terms of climate resilience and adaptation.

Respectfully submitted,
Susan

Susan D. Chapnick, M.S.

President & Principal Scientist

NEH, Inc.

2 Farmers Cir

Arlington, MA 02474

ph: 617-643-4294

www.neh-inc.com





To: Artificial Turf Study Committee – Communication
Date: December 15, 2023
From: Susan D. Chapnick, M.S.

Subject: Adverse Impacts of Artificial Turf Fields

The current scientific weight-of-evidence points to adverse impacts on the environment, especially in and around protected wetland resource areas, and negative climate resilience impacts of Artificial Turf Fields. The practicable alternative is organically managed natural turf fields that are well-constructed for improved drainage.

Adverse Impacts

- 1) Chemical Pollution: Toxic chemicals harmful to wetland resource areas can migrate through leaching, airborne dust, volatilization, and physical migration of infill particles. Known toxic chemicals including zinc, lead, polyaromatic hydrocarbons (PAHs), phthalates (endocrine disruptors), and volatile organic compounds (VOCs), have been documented (1, 2, 5, 6). Direct toxicity to aquatic organisms has been documented from Artificial Turf Field surface runoff during rainstorms based on whole effluent toxicity and Zinc toxicity (3). PFAS, the “forever” chemical, is found mainly in the grass blades and carpet backing material. PFAS environmental impacts from artificial turf are under-studied, but part-per-trillion (ppt) levels have been shown to have adverse effects (6) and PFAS has been documented to leach from Artificial Turf Fields (8). EPA is expecting to publish aquatic life criteria for PFAS in 2023 (9). Furthermore, recent scientific studies and reports (10, 11) have shown that an emerging contaminant, the chemical “6ppd-quinone” that is derived from the oxidation/weathering of tires, is acutely toxic to freshwater fish (rainbow trout and brook trout) – meaning it is the cause of fish kills. Tire crumb rubber is currently the most commonly used infill in artificial turf fields. Therefore, artificial turf fields with crumb rubber infill will leach 6ppd-quinone into the environment and aquatic systems.
- 2) Heat Effects: Artificial turf fields exacerbate heat stress in already stressed urban resource areas. This has negative environmental and human impacts and can be an environmental justice (EJ) issue due to increased heat island effects in EJ communities. Temperatures of over 150 degrees F have been routinely recorded on Artificial Turf Fields during June and summer months, compared to natural grass fields with temperatures of less than 90 degrees F (5). Cooling of artificial turf fields for use by spraying water exacerbates chemical, plastic, and particulate pollution. Increased heat effects due to climate change will add, for example, 13 to 23 days of greater than 90 degrees F from the current 8 days per year in the town of Arlington (Table 26, reference 7).
- 3) Plastic Pollution: Synthetic grass fibers are made of polyethylene or polypropylene plastic. Plastic and rubber infill particles migrate into resource areas, resulting in plastic and microplastic pollution. Plastics are a known source of endocrine disruptors. Plastics and microplastics are consumed by aquatic organisms and negatively impact the ecosystem.

- 4) Particulate Pollution: Crumb rubber infill and weathered plastic blades routinely migrate from older fields into the surrounding resource areas. This has been directly observed in Arlington, at the Arlington Catholic High School artificial turf field, which is within 100 feet of a protected brook (reference Arlington Conservation Commission communication and site pictures through March 2023, included in the public record).
- 5) Adverse Climate Change Resilience: heat stress negatively impacts habitat values, increased pollutant loads from surface runoff and infill particulate migration, loss of carbon sequestration as a climate resilience strategy due to removal of soil (15), limited useful lifespan (8-10 years) generates additional, recurrent installation impacts on the environment and the surrounding community.
- 6) Adverse Impacts on the environment/wildlife habitat from Artificial Turf fields include: toxicity to aquatic life from crumb rubber infill (including fish deaths and reproductive stress), loss of habitat for insects and other invertebrates (especially burrowing organisms), limited foraging and prey availability for birds and small mammals, loss of pollinator use, disrupted habitat connectivity, and impacts to species composition and the water cycle owing to extreme heat.

Practicable Alternative

Organically managed natural turf fields employing aeration & mowing techniques and/or over similar stormwater infiltration systems used below artificial turf fields allow for:

- 1) improved drainage;
- 2) reduces the need for extensive nutrients and harmful chemical/pesticide treatments;
- 3) allows for some habitat functions including wildlife corridor connectivity;
- 4) is a more climate resilient alternative because it is sustainable, has lower heat effects, and less pollution runoff.

Examples in the Commonwealth of successful organically managed natural turf fields include: Springfield with 67 acres of organically managed athletic fields (12), Marblehead with 20 acres of organically managed athletic fields (13), and Martha's Vineyard (14). The Toxic Use Reduction Institute (TURI) report includes a cost comparison table for Artificial Turf vs. Organically managed Natural Turf (4).

References included on the following page.

Susan D. Chapnick, M.S. – Bio

Susan Chapnick is President and Principal Scientist of New Environmental Horizons, Inc. (NEH), an environmental chemistry consulting firm specializing in the planning and evaluation of environmental data. She also leads local policy changes towards Climate Change Resilience and adaptation planning in wetland resource areas as the Chair of the Conservation Commission in the Town of Arlington, MA. She is recognized as a technical expert with over 30 years of experience in analytical chemistry and quality assurance of environmental measurements for complex investigations in support of Natural Resource Damage Assessments, USEPA Superfund, US Army Corps of Engineers, and state-led programs. Additionally, Ms. Chapnick serves on the Science Advisory Committee for the MassDEP Bureau of Waste Site Cleanup where she champions scientific integrity in the development of environmental regulations and technical guidance for site cleanups in the Commonwealth. Ms. Chapnick holds a Master's of Science in Marine Science from the University of South Carolina and a BA in Biological Sciences from Barnard College.

References:

- 1) EPA, July 2019: Tire Crumb Rubber Characterization
<https://www.epa.gov/chemical-research/july-2019-report-tire-crumb-rubber-characterization-0>
- 2) R. Massey, L. Pollard, & H. Harari, Journal of Environmental & Occupational Health Policy, February 23, 2020 (Vol 30, Issue 1): Artificial Turf Infill: A comparative Assessment of Chemical Contents
<https://journals.sagepub.com/doi/full/10.1177/1048291120906206>
- 3) CTDEP, July 2010: Artificial Turf Study: Leachate and Stormwater Characteristics
<https://portal.ct.gov/-/media/DEEP/artificialturf/DEPArtificialTurfReportpdf.pdf>
- 4) TURI, September 2020: Athletic Playing Fields & Artificial Turf: Considerations for Municipalities and Institutions
https://www.turi.org/content/download/13271/203906/file/Factsheet.Artificial_Turf.September2020.pdf.pdf
- 5) TURI, April 2019 (updated): Athletic Playing Fields – Choosing Safer Options for Health and the Environment
<https://www.turi.org/content/download/11980/188623/file/TURI+Report+2018-002+June+2019.+Athletic+Playing+Fields.pdf>
- 6) TURI, February 2020: Per- and Poly-fluoroalkyl Substances (PFAS) in Artificial Turf Carpet
<https://www.turi.org/content/download/12963/201149/file/TURI+fact+sheet+-+PFAS+in+artificial+turf.pdf>
- 7) Town of Arlington Hazard Mitigation Plan – 2020 update
<https://www.arlingtonma.gov/home/showpublisheddocument/51627/637268071185670000>
- 8) York Analytical Data for PFAS from swale runoff of Amity High School Artificial Turf Field in Woodbridge, CT, 2021
<https://subscriber.politicopro.com/eenews/f/eenews/?id=00000181-b526-d010-a3cb-b5aed1070000>
- 9) PFAS Strategic Roadmap: EPA's Commitments to Action 2021-2024
https://www.epa.gov/system/files/documents/2021-10/pfas-roadmap_final-508.pdf
- 10) Acute Toxicity of the Tire Rubber-Derived Chemical 6PPD-quinone to Four Fishes of Commercial, Cultural, and Ecological Importance, March 2022
<https://pubs.acs.org/doi/10.1021/acs.estlett.2c00050>
- 11) Product – Chemical Profile for Motor Vehicle Tires Containing N-(1,3-Dimethylbutyl)-N'-phenyl-p-phenylenediamine (6PPD), 2022
https://dtsc.ca.gov/wp-content/uploads/sites/31/2022/05/6PPD-in-Tires-Priority-Product-Profile_FINAL-VERSION_accessible.pdf
- 12) City of Springfield, June 2019: Natural Grass Playing Field Case Study
<https://www.turi.org/content/download/12156/190509/file/Natural+Grass+Playing+Field+Case+Study+Springfield+MA.+June+2019.pdf>
- 13) Marblehead, November 2020 (revised): Natural Grass Playing Field Case Study: Marblehead, MA
<https://www.turi.org/content/download/12705/198916/file/Natural+Grass+Playing+Field+Case+Study+Marblehead+MA+revised.Nov2020.pdf>
- 14) Martha's Vineyard, December 2020: Natural Grass Playing Field Case Study: Martha's Vineyard, MA
<https://www.turi.org/content/download/13432/205432/file/Natural+Grass+Playing+Field+Case+Study+MV+MA.Dec2020.pdf>
- 15) The Massachusetts Healthy Soils Action Plan, 2022-2023
<https://www.mass.gov/doc/healthy-soils-action-plan-2023/download>

Athletic Playing Fields and Artificial Turf: Considerations for Municipalities and Institutions

This fact sheet introduces some of the considerations that are relevant to evaluating natural grass and artificial turf playing surfaces. For more of TURI's research on artificial turf and natural grass, see www.turi.org/artificialturf.

Principles of toxics use reduction

TURI's work is based on the principles of toxics use reduction (TUR). The TUR approach focuses on identifying opportunities to reduce or eliminate the use of toxic chemicals as a means to protect human health and the environment. Projects to reduce the use of toxic chemicals often have additional benefits, such as lower life-cycle costs.

Children's environmental health

People of all ages benefit from a safe and healthy environment for work and play. However, special concerns exist for children. Children are uniquely vulnerable to the effects of toxic chemicals because their organ systems are developing rapidly and their detoxification mechanisms are immature. Children also breathe more air per unit of body weight than adults, and are likely to have more hand-to-mouth exposure to environmental contaminants than adults.¹ For these reasons, it is particularly important to make careful choices about children's exposures.

Artificial turf and chemicals of concern

Artificial turf has several components, including drainage materials, a cushioning layer, synthetic grass carpet (support and backing materials and synthetic fibers to imitate grass blades), and infill that provides cushioning and keeps grass carpet blades standing upright. Here, we briefly review issues related to chemicals in synthetic grass carpet and infills.

Crumb rubber infill made from recycled tires. Crumb rubber made from recycled tires is widely used as infill. This material is also referred to as styrene butadiene rubber (SBR), or as tire crumb. Many peer-reviewed studies have examined the chemicals present in tire crumb. Tire crumb contains a large number of chemicals, many of which are known to be hazardous to human health and the environment. These include polyaromatic hydrocarbons (PAHs); volatile organic compounds (VOCs); metals, such as lead and zinc; and other chemicals.²⁻⁵ Some of the chemicals found in tire crumb are known to cause cancer.⁶⁻⁸ Because of the large number of chemicals present in the infill, as well as the health effects of individual chemicals, crumb rubber made from recycled tires is the option that likely presents the most concerns related to chemical exposures.



Other synthetic infills. Other synthetic materials used to make artificial turf infill include ethylene propylene diene terpolymer (EPDM) rubber, thermoplastic elastomers (TPE), waste athletic shoe materials, and acrylic-coated sand, among others. These materials also contain chemicals of concern, although the total number of chemicals and/or the concentration of chemicals of concern may be lower in many cases.⁵ For more information on chemicals in these materials, see TURI's report, [Athletic Playing Fields: Choosing Safer Options for Health and the Environment](#).⁹

Mineral-based and plant-derived materials. Other materials used as infill can include sand, zeolite, cork, coconut hulls, walnut shells, olive pits, and wood particles, among other materials. These materials are likely to contain fewer hazardous chemicals than tire crumb, but many of the materials have not been well characterized or studied thoroughly.⁵ Some plant-based materials may raise concerns related to allergies or respirable fibers. In addition, zeolite and sand can pose respiratory hazards. Exposure to some types of zeolites may be associated with increased risk of developing mesothelioma, a type of cancer.^{10,11} Using zeolite can be considered a regrettable substitution. For sand, it is important to understand the source and type of the material; industrial sand that is freshly fractured or that has been highly processed to contain very small particles can be a respiratory hazard when inhaled.⁵

Synthetic grass carpet. Toxic chemicals such as lead are also found in the artificial grass blades in some cases.^{6,7} Recent research has identified per- and poly-fluoroalkyl substances (PFAS) in some artificial turf carpet materials. PFAS are a group of chemicals that are highly persistent in the environment. PFAS do not break down under normal environmental conditions, and some can last in the

environment for hundreds of years or longer. As a result, introducing these chemicals into the environment has lasting consequences. Health effects documented for some PFAS include effects on the endocrine system, including liver and thyroid, as well as metabolic effects, developmental effects, neurotoxicity, and immunotoxicity. For more information, see TURI's fact sheet, "[Per- and Poly-fluoroalkyl Substances \(PFAS\) in Artificial Turf Carpet](#)."¹²

Artificial turf and heat stress

In sunny, warm weather, artificial turf can become much hotter than natural grass, raising concerns related to heat stress for athletes playing on the fields. Elevated surface temperatures can damage equipment and burn skin, and can increase the risk of heat-related illness.¹³ Heat-related illness can be a life-threatening emergency. Experts note that athletic coaches and other staff need to be educated about heat-related illness and understand how to prevent it, including cancelling sport activities when necessary.^{14,15}

Research indicates that outdoor synthetic turf reaches higher temperatures than natural grass, regardless of the infill materials or carpet fiber type.¹³ The Penn State Center for Sports Surface Research measured surface temperature for infill alone, artificial grass fibers, and a full synthetic turf system. The study included several types and colors of infill and fibers. They found that all the materials reached high temperatures than grass when heated indoors (with a sun lamp), or outdoors.

Irrigation can lower field temperature for a short time. A Penn State study found that frequent, heavy irrigation reduced temperatures on synthetic turf, but temperatures rebounded quickly under sunny conditions.¹⁶ Other studies found similar results.¹⁷

Approaches to determining safe temperatures for recreational field spaces. Several methods are available for measuring heat in a play area. It is sometimes necessary to use more than one method in order to determine whether conditions are safe for exercise or play.

One heat metric, Wet Bulb Globe Temperature (WBGT), takes into account ambient air temperature, relative humidity, wind, and solar radiation from the sun. WBGT can help to guide precautions such as rest, hydration breaks, and cancellation of sports activities. However, WBGT may does not take account of field surface temperature.

Another approach is to measure the temperature of the playing field surface itself. One researcher has noted that artificial turf surface temperatures are not captured by either a heat advisory or by wet bulb temperature, and that "elevated risk of heat stress can stem from infrared heating from the ground, regardless of the air temperature." Thus, the researcher suggests, greater caution regarding heat is needed when athletes are playing on artificial turf, "even if the air temperature is not at an otherwise unsafe level."¹⁸

WBGT is used as the basis for a heat policy adopted by Massachusetts Interscholastic Athletic Association (MIAA) in 2019. This policy requires schools to select a method to monitor heat during all sports related activities, and modify activities as needed to protect student athletes.¹⁹ The MIAA policy does not provide guidelines based on the type of playing surface, and does not take account of surface temperature specifically.

The school board of Burlington, MA has taken additional steps to protect student athletes by ensuring that both WBGT and surface temperature are taken into account.²⁰ Burlington's policy, "[Utilizing Artificial Turf in the Heat](#)," requires use of an infrared heat gun to determine field surface temperature. The policy includes information about the conditions under which athletes may use artificial turf fields and the conditions under which their activities must be moved to grass fields. For example, the policy states that if the National Weather Service issues a Heat Advisory, artificial turf cannot be used for physical education if the air temperature is higher than 85 degrees with humidity 60 percent or more. Under these conditions, only a grass surface may be used. The policy also lays out criteria to be taken into account in determining activity levels. For example, when air temperature is below 82 degrees, activities are permitted on artificial turf up to a surface temperature of 120 degrees, with three water breaks per hour. Above this surface temperature, activities must be moved to a grass field.

Injuries

Studies show variable outcomes in the rates and types of injuries experienced by athletes playing on natural grass and on artificial turf.^{6,21,22} Among recent studies and reviews of studies, several suggest an increase in foot and/or ankle injuries on artificial turf as compared with natural grass²³⁻²⁵; several find no difference²⁶; and one suggests a possibly lowered risk on artificial turf.²⁷ All of these studies recommend further evaluation of this question.

One particular concern is increased rates of turf burns (skin abrasions) associated with playing on artificial turf. For example, a study by the California Office of Environmental Health Hazard Assessment found a two- to three-fold increase in skin abrasions per player hour on artificial turf compared with natural grass turf.⁶ The study authors noted that these abrasions are a risk factor for serious bacterial infections, although they did not assess rates of these infections among the players they studied.

Environmental concerns

Environmental concerns include loss of wildlife habitat, migration of synthetic particles into the environment, and contaminated stormwater runoff. A study by the Connecticut Department of Environmental Protection identified concerns related to a number of chemicals in stormwater runoff from artificial turf fields. They noted high zinc concentrations in

stormwater as a particular concern for aquatic organisms. They also noted the potential for leaching of high levels of copper, cadmium, barium, manganese and lead in some cases. The top concerns identified in the study were toxicity to aquatic life from zinc and from whole effluent toxicity (WET).²⁸ WET is a methodology for assessing the aquatic toxicity effects of an effluent stream as a whole.²⁹ In addition, scientists have raised concerns about the contribution of artificial turf materials to microplastic pollution.³⁰⁻³²

Safer alternative: organically managed natural grass

Natural grass fields can be the safest option for recreational space, by eliminating many of the concerns noted above. Natural grass can also reduce overall carbon footprint by capturing carbon dioxide. Grass fields may be maintained organically or with conventional or integrated pest management (IPM) practices. Organic turf management eliminates the use of toxic insecticides, herbicides and fungicides.

Organic management of a recreational field space requires a site-specific plan to optimize soil health. Over time, a well-maintained organic field is more robust to recreational use due to a stronger root system than that found in a conventionally managed grass field. Key elements of organic management include the following.³³

- **Field construction:** Construct field with appropriate drainage, layering, grass type, and other conditions to support healthy turf growth. Healthy, vigorously growing grass is better able to out-compete weed pressures, and healthy soil biomass helps to prevent many insect and disease issues.
- **Soil maintenance:** Add soil amendments as necessary to achieve the appropriate chemistry, texture and nutrients to support healthy turf growth. Elements include organic fertilizers, soil amendments, microbial inoculants, compost teas, microbial food sources, and topdressing as needed with high-quality finished compost.
- **Grass maintenance:** Turf health is maintained through specific cultural practices, including appropriate mowing, aeration, irrigation, and over-seeding. Trouble spots are addressed through composting and re-sodding where necessary. Aeration is critical because it makes holes in the soil that allow more air, water and nutrients to reach the roots of the grass and the soil system. Stronger roots make the grass better able to naturally fend off weeds and pests. Aeration also breaks up areas of compacted soil.

Massachusetts communities investing in organic grass fields. In Massachusetts, the city of [Springfield](#) and the town of [Marblehead](#) have both been successful in managing athletic fields organically. These communities' experiences are documented in case studies.^{34,35} In addition, the Field Fund in Martha's Vineyard has invested in organic maintenance of a number of athletic fields and has documented the process at www.fieldfundinc.org.

Installation and maintenance costs: comparing artificial turf with natural grass

In analyzing the costs of artificial vs. natural grass systems, it is important to consider full life-cycle costs, including installation, maintenance, and disposal/replacement. Artificial turf systems of all types require a significant financial investment at each stage of the product life cycle. In general, the full life cycle cost of an artificial turf field is higher than the cost of a natural grass field.

Cost information is available through university entities, turf managers' associations, and personal communications with professional grounds managers. Information is also available on the relative costs of conventional vs. organic management of natural grass.

Installation. According to the Sports Turf Managers Association (STMA), the cost of installing an artificial turf system may range from \$4.50 to \$10.25 per square foot. For a football field with a play area of 360x160 feet plus a 15-foot extension on each dimension (65,625 square feet), this yields an installation cost ranging from about \$295,000 to about \$673,000. These are costs for field installation only, and full project costs may be higher. Costs for a larger field would also be higher.

In one site-specific example, information provided by the town of Natick, Massachusetts shows that the full project budget for the installation in 2015 of a new artificial turf field (117,810 square feet), along with associated landscaping, access and site furnishings, totaled \$1.2 million.³⁶

For natural grass, installation of a new field may not be necessary. For communities that do choose to install a new field, costs can range from \$1.25 to \$5.00 per square foot, depending on the type of field selected. For the dimensions noted above, this would yield an installation cost ranging from about \$82,000 to about \$328,000.³⁷ However, in many cases communities are simply able to improve existing fields.

Maintenance. Maintenance of artificial turf systems can include fluffing, redistributing and shock testing infill; periodic disinfection of the materials; seam repairs and infill replacement; and watering to lower temperatures on hot days. Maintenance of natural grass can include watering, mowing, fertilizing, replacing sod, and other activities. Communities shifting from natural grass to artificial turf may need to purchase new equipment for this purpose. According to STMA, maintenance of an artificial turf field may cost about \$4,000/year in materials plus 300 hours of labor, while maintenance of a natural grass field may cost \$4,000 to \$14,000 per year for materials plus 250 to 750 hours of labor.³⁷

Springfield, MA manages 67 acres of sports fields, park areas, and other public properties organically. Field management costs in 2018, including products, irrigation maintenance, and all labor costs, were just under \$1,500 per acre across all of the properties.³⁴

Natural grass maintenance: Conventional vs. organic costs. Organic turf maintenance can be cost-competitive with conventional management of natural grass. One study found that once established, an organic turf management program can cost 25% less than a conventional turf management program.³⁸

Disposal/replacement. Artificial turf requires disposal at the end of its useful life. STMA estimates costs of \$6.50 to \$7.80 per square foot for disposal and resurfacing.³⁷ Those estimates yield \$426,563–\$511,875 for a 65,625 square foot field and \$552,500–\$663,000 for an 85,000 square foot field.

Disposal is an increasing source of concern. Used synthetic turf is projected to produce between 1 million and 4 million tons of waste over the next decade, but there is a lack of plans or guidance for its disposal.^{39,40} In most cases it cannot be completely recycled, and disposing of it in landfills is expensive and not an industry best practice, according to one article.³⁹ Used turf that is dumped illegally near a body of water can attract pests, and piles can pose a fire risk.³⁹

Life-cycle costs. In 2008, a Missouri University Extension study calculated annualized costs for a 16-year scenario. The calculation included the capital cost of installation; annual maintenance; sod replacement costing \$25,000 every four years for the natural fields; and surface replacement of the synthetic fields after eight years. Based on this calculation, a natural grass soil-based field is the most cost effective, followed by a natural grass sand-cap field, as shown in the table below.⁴¹ Another study, conducted by an Australian government agency, found that the 25-year and 50-year life cycle costs for synthetic turf are about 2.5 times as large as those for natural grass.⁴²

Table 1: Comparison of life-cycle costs

Field type	16-year annualized costs
Natural soil-based field	\$33,522
Sand-cap grass field	\$49,318
Basic synthetic field	\$65,849
Premium synthetic field	\$109,013

Source: Brad Fresenburg, "More Answers to Questions about Synthetic Fields – Safety and Cost Comparison." University of Missouri.

References

- Landrigan, P. J. Environmental hazards for children in USA. *Int. J. Occup. Med. Environ. Health* **11**, 189–94 (1998).
- National Toxicology Program (NTP). *The Chemical and Physical Characterization of Recycled Tire Crumb Rubber*; NTP RR-11. (2019).
- US Environmental Protection Agency. July 2019 Report: Tire Crumb Rubber Characterization. (2019). Available at: <https://www.epa.gov/chemical-research/july-2019-report-tire-crumb-rubber-characterization-0>. (Accessed: 20th March 2020)
- US Environmental Protection Agency (US EPA). *Federal Research Action Plan on Recycled Tire Crumb Used on Playing Fields and Playgrounds: Status Report*. EPA/600/R-16/364. (2016).
- Massey, R., Pollard, L., Jacobs, M., Onasch, J. & Harari, H. Artificial turf infill: a comparative assessment of chemical contents. *New Solut.* **30**, 10–26 (2020).
- Office of Environmental Health Hazard Assessment (OEHA). Safety Study of Artificial Turf Containing Crumb Rubber Infill Made From Recycled Tires: Measurements of Chemicals and Particulates in the Air, Bacteria in the Turf, and Skin Abrasions Caused by Contact with the Surface. (2010).
- Pavilonis, B. T., Weisel, C. P., Buckley, B. & Lioy, P. J. Bioaccessibility and Risk of Exposure to Metals and SVOCs in Artificial Turf Field Fill Materials and Fibers. *Risk Anal.* **34**, 44–55 (2014).
- Claudio, L. Synthetic turf: health debate takes root. *Environ. Health Perspect.* **116**, A116–22 (2008).
- Toxics Use Reduction Institute (TURI). *Athletic Playing Fields: Choosing Safer Options for Health and the Environment*. TURI Report #2018-002. (2018).
- Suzuki, Y. & Kohyama, N. Malignant mesothelioma induced by asbestos and zeolite in the mouse peritoneal cavity. *Environ. Res.* **35**, 277–92 (1984).
- Weissman, David and Kiefer, M. Erionite: An Emerging North American Hazard | | Blogs | CDC. (2011). Available at: <https://blogs.cdc.gov/niosh-science-blog/2011/11/22/erionite/>. (Accessed: 13th December 2018)
- Toxics Use Reduction Institute (TURI). *Per- and Poly-fluoroalkyl Substances (PFAS) in Artificial Turf Carpet*. (2020).
- Pennsylvania State University Center for Sports Surface Research. *Synthetic Turf Heat Evaluation-Progress Report*. (2012).
- Howe, A. S. & Boden, B. P. Heat-related illness in athletes. *Am. J. Sports Med.* **35**, 1395 (2007).
- Johns Hopkins Medicine. Heat-Related Illness and Young Athletes: 3 Important Things Parents and Coaches Need to Know. Available at: <https://www.hopkinsmedicine.org/health/wellness-and-prevention/heat-related-illness-and-young-athletes-3-important-things-parents-and-coaches-need-to-know>. (Accessed: 20th March 2020)
- Pennsylvania State University Center for Sports Surface Research. *The Effect of Irrigation on Synthetic Turf Characteristics Surface Temperature, Soccer Ball Roll, and Traction- Progress Report*. (2015).
- Milone and MacBroom Inc. *Evaluation of the Environmental Effects of Synthetic Turf Athletic Fields*. (2008).
- Abraham, J. Heat risks associated with synthetic athletic fields. *Int. J. Hyperth.* **36**, 516–517 (2019).
- Massachusetts Interscholastic Athletic Association. *MIAA Heat Modification Policy, Adopted Jan. 16, 2019, Effective July 1, 2019*. (2019).
- Burlington MA Public Schools. Utilizing Artificial Turf in the Heat. (2017). Available at: <https://www.burlingtonpublicschools.org/district/district-policies/utilizing-artificial-turf>.
- Meyers, M. C. & Barnhill, B. S. Incidence, causes, and severity of high school football injuries on FieldTurf versus natural grass: A 5-year prospective study. *Am. J. Sports Med.* **32**, 1626–1638 (2004).
- Dragoo, J. L. & Braun, H. J. The effect of playing surface on injury rate: A review of the current literature. *Sport. Med.* **40**, 981–990 (2010).
- Winson, D. M. G., Miller, D. L. H. & Winson, I. G. Foot injuries, playing surface and shoe design: Should we be thinking more about injury prevention. *Foot Ankle Surg.* (2019). doi:10.1016/j.fas.2019.07.013
- Miyamori, T. *et al.* Playing football on artificial turf as a risk factor for fifth metatarsal stress fracture: A retrospective cohort study. *BMJ Open* **9**, e022864 (2019).
- Williams, S., Hume, P. A. & Kara, S. A review of football injuries on third and fourth generation artificial turfs compared with natural turf. *Sport. Med.* **41**, 903–923 (2011).
- Calloway, S. P. *et al.* Injury Surveillance in Major League Soccer: A 4-Year Comparison of Injury on Natural Grass Versus Artificial Turf Field. *Am. J. Sports Med.* **47**, 2279–2286 (2019).
- Williams, J. H., Akogyrem, E. & Williams, J. R. A Meta-Analysis of Soccer Injuries on Artificial Turf and Natural Grass. *J. Sports Med.* **2013**, (2013).
- Connecticut Department of Environmental Protection. *Artificial Turf Study: Leachate and Stormwater Characteristics*. (2010).
- US Environmental Protection Agency. Whole Effluent Toxicity Methods. (2016). Available at: <https://www.epa.gov/cwa-methods/whole-effluent-toxicity-methods>. (Accessed: 20th March 2020)

30. Bauer, B., Egebaek, K. & Aare, A. K. *Environmentally friendly substitute products for rubber granulates as infill for artificial turf fields. Report M-955/2018.* (2018).
31. Chemical Watch. Norway consults on proposal to curb artificial turf microplastics emissions. *Chemical Watch* (2019). Available at: <https://chemicalwatch.com/79366/norway-consults-on-proposal-to-curb-artificial-turf-microplastics-emissions>. (Accessed: 14th August 2020)
32. Hann, S. *et al. Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products Final Report.* (2018).
33. Osborne, C. Personal communication, December 2015.
34. Toxics Use Reduction Institute (TURI). Natural Grass Playing Field Case Study : Springfield , MA Organic Grass Fields Meet Athletes ' Needs and Protect Connecticut River Watershed. 1–12 (2019).
35. Toxics Use Reduction Institute (TURI). *Natural Grass Playing Field Case Study : Marblehead , MA: 20 Acres of Organically Managed Playing Fields.* (2019).
36. Goodhind A. Town of Natick Land Facilities and Natural Resources Supervisor. Personal communication April 11, 2016.
37. Sports Turf Managers Association (STMA). *A Guide to Synthetic and Natural Turfgrass for Sports Fields Selection, Construction and Maintenance Considerations, 3rd edition.*
38. Osborne, C. & Wood, D. *A Cost Comparison of Conventional (Chemical) Turf Management and Natural (Organic) Turf Management for School Athletic Fields .* (2010).
39. Woodall, C. Paper: Old turf fields raise environmental, health concerns. *AP News* (2019). Available at: <https://apnews.com/e2c4b4fc51854dffa15774f83cc104f9>. (Accessed: 20th March 2020)
40. Lundstrom, M., Wolfe, E. & Fairwarning. The dangerous pileup of artificial turf. *The Atlantic* (2019). Available at: <https://www.theatlantic.com/science/archive/2019/12/artificial-turf-fields-are-piling-no-recycling-fix/603874/>. (Accessed: 2nd April 2020)
41. Fresenburg, B. *More Answers to Questions about Synthetic Fields-Safety and Cost Comparison, PowerPoint slides obtained via email December 2015.* (2015).
42. Government of Western Australia Department of Sport and Recreation. Natural Grass vs Synthetic Turf Study Report. Available at: <https://dlgsc.wa.gov.au/funding/sport-and-recreation-funding/community-sporting-and-recreation-facilities-fund/natural-grass-vs-synthetic-turf-study-report>. (Accessed: 20th March 2020)

MassDEP WPA proposed definition of Impervious Surface includes Artificial Turf

Susan D. Chapnick <s.chapnick@comcast.net>

Tue 1/2/2024 2:20 PM

To:BOH <BOH@town.arlington.ma.us>

Cc:mikeg125@gmail.com <mikeg125@gmail.com>;David Morgan <dmorgan@town.arlington.ma.us>

CAUTION: This email originated from outside your organization. Exercise caution when opening attachments or clicking links, especially from unknown senders.

Natasha and Committee members,

Please accept this communication that includes updated information from MassDEP proposed Wetlands Protection Act (WPA) draft revisions (December 2023), which defines "Impervious Surface" to include artificial turf. This is important in considerations of stormwater management and in siting artificial turf fields in wetland resource areas and buffer areas.

Here is a link to the proposed updates: <https://www.mass.gov/doc/310-cmr-1000-wetlands-proposed-revisions-redlinestrikeout/download>

Here is DEP's proposed definition for ease of reference:

Impervious Surface means, for purposes of stormwater management (310 CMR 10.05(6)(k)-(q)), any surface that prevents or significantly impedes the infiltration of water into the underlying soil, including, but not limited to artificial turf, Compacted Gravel or Soil, roads, building rooftops, solar arrays, parking lots, Public Shared Use Paths, bicycle paths, and sidewalks paved with concrete, asphalt, or other similar materials. For purposes of this definition, porous pavements are Impervious Surfaces in order to size the depth of the underlying reservoir course to meet recharge and Total Suspended Solids/Total Phosphorus removal requirements pursuant to 310 CMR 10.05(6)(k)3. and 4.

Respectfully submitted,
Susan

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Belmont high school fields

Mike Gildesgame <mikeg125@gmail.com>

Tue 1/2/2024 6:43 PM

To: Natasha Waden <nwaden@town.arlington.ma.us>

Cc: jobar@alum.mit.edu <jobar@alum.mit.edu>

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Hi Natasha

Please add this to the committee's record.

I think Mary's response to my inquiry about the new high school building in Belmont is helpful as we discuss issues of natural versus artificial turf, especially the issue of capital and lifetime costs of these options. I am not sure which of the three subgroups might look at this, but I believe it is an essential component of the committee's work.

Mike Gildesgame

From: "Trudeau, Mary" <mtrudeau@belmont-ma.gov>

Date: Tuesday, January 2, 2024 at 12:38 PM

To: "mikeg125@gmail.com" <mikeg125@gmail.com>

Subject: RE: [EXTERNAL][belmontma] Belmont high school fields (Sent by Mike Gildesgame, mikeg125@gmail.com)

Hi Mike,

As you suspected, the town of Belmont discussed the use of artificial turf fields during the development of the plans for the new High School and Middle School complex, on Concord Avenue. There was some concern from the parent community about toxicity and heat generation, but the conversation in Belmont was largely driven by finances. The Conservation Commission weighed in on the fields, but the decision to pursue natural turf was ultimately made by the School Building Committee. The School Building Committee is charged with building the school, and does not consider the annual costs of upkeep and maintenance. For this reason, I believe the School Building Committee focused on the natural fields as an option (as they are less expensive to construct). In the end, the playing fields constructed at the complex were not artificial turf, although I believe one field (which predates the school reconstruction) remains artificial turf.

My recollection is that the discussions, which included concerns about toxicity of the artificial field substrate versus the toxicity of the chemicals used to maintain playing fields, dominated the conversation with the Conservation Commission. The Commission was concerned with the use of chemicals to maintain heavily utilized playing fields, versus the toxicity of the bedding used in the artificial turf products. There was also quite a bit of debate relating to long term maintenance costs of the options. The turf fields are more expensive to construct, but arguably less expensive to maintain over the predicted lifespan. Maintenance costs are the responsibility of the Town operating budget, and construction costs are the purview of the School Building Committee. In any case, the School Building Committee ultimately proposed the construction of natural fields---and I suspect cost (rather than toxicity) was the driver.

Bill Lovallo wlovallo@lemessurier.com was the chair of the School Building Committee, and he is probably the best person to quantify the decision making process. I suggest reaching out to him. The Belmont Conservation Commission has not taken a stance on the issue, partially because the School Building Committee did not go forward with artificial fields at the new school complex.

Best, Mary

Materials for the Arlington Artificial Turf Study Committee

Wendy Heiger-Bernays <whb@bu.edu>

Thu 1/4/2024 4:11 PM

To: Natasha Waden <nwaden@town.arlington.ma.us>; Christine Bongiorno <CBongiorno@town.arlington.ma.us>

Cc: Joanne Belanger <jbelanger@lexingtonma.gov>

 2 attachments (1 MB)

Joint Statement 10.6.23.pdf; PFAS Primer-Weston Sampson.pdf;

CAUTION: This email originated from outside your organization. Exercise caution when opening attachments or clicking links, especially from unknown senders.

Hello Natasha and Christine,

I have received some questions about materials that appear to be part of the docket for consideration by the Arlington Artificial Turf Study Committee - specifically those that pertain to the work of the

Lexington Artificial Turf Working Group. For the record, I am attaching the Joint Statement prepared by the Lexington Working Group that includes specifications for artificial turf for replacement of an existing artificial turf field (Lincoln Field #1). This point is important - that an existing artificial turf field that lies over a municipal landfill is being replaced - this is not converting a natural field to artificial turf one. There are Conservation Commission issues related to the original permitting, that should be noted, but this was not our purview.

In addition, there is a document prepared by Weston & Sampson that I attach here - this is not from Lexington - in fact the language used in the document is not acceptable or accurate.

Happy to discuss,

Respectfully,

Wendy Heiger-Bernays, PhD

Chair, Lexington Board of Health

Working Group Memo – October 6, 2023

This memo summarizes the results of the Lincoln Field Working Group's activities to develop specifications for the resurfacing of Lincoln Field 1 and to establish an approach to address the needs for functional performance, health and safety of users, and environmental impact for future capital projects. The Working Group has agreed that the planned specifications are appropriate for the resurfacing of Lincoln Field 1 and should be included in the bid package to be released this fall.

The Working Group came together to ensure that health, safety and environmental concerns associated with artificial turf were considered along with the functional needs of fields at Lincoln Park. Working Group members reviewed relevant literature collected by group members, visited fields that used different technologies, and met with representatives from Brock USA and Town consultants (Activitas). The results of this work have been captured in updates to the proposed specifications for the field.

Regarding the short-term need to establish specifications for the resurfacing of Lincoln Field 1, the Working Group has helped to identify turf field components that satisfy the functional needs of the field by using the best, currently available technologies to address concerns related to health, safety and environmental impacts. The specifications call for:

- **Infill:** Brockfill (or similar) is specified - A wood particle infill specifically designed to improve traction and reduce artificial turf heat. It is made from a species of southern pine grown, harvested, and replanted in continuous cycles.
- **Resilient Underlayment (Shock Pad):** Brock SP-17 (or similar) is specified - A patented material using polypropylene with a micro coating binder produces a material with an open pore structure for fast drainage and a unique impact profile ideal for artificial turf.
- **Disposal:** Contractor shall provide a full, detailed accounting of the fate of removed turf materials. Waste disposal via incineration or waste-to-energy is not permitted. So-called 'advanced recycling' or 'chemical recycling' are not forms of actual recycling and are not permitted.
- **Testing:** Artificial turf [all the components] is manufactured in such a way that fluorinated chemicals, including PFAS, are integral to the process. There are at least seven definitions currently used to define per and polyfluoroalkyl substances (PFAS). By defining and testing for only the six PFAS that are currently regulated in Massachusetts, or even a few others, the remaining thousands of PFAS are not accounted for. All PFAS contain organofluorine(s). By using a screening method that identifies the group of chemicals that contain organofluorine, a more complete assessment of the PFAS present in turf materials is obtained. Analytical test results for total organofluorine and metals shall be submitted by vendors for informational purposes to provide the Town with an indication of the levels of these chemicals in the turf materials.

While these materials will increase/change some maintenance requirements and could affect field playability during the particularly cold/wet times of the year, the Working Group's consensus was that these potential impacts to athletic operations are acceptable given the health, safety and environmental benefits of not using crumb rubber infill.

The materials used in turf fields and the approaches to manage and assess those materials are evolving rapidly. The Working Group recommends that the Recreation Department integrate the evaluation of project materials for health, safety and environmental impacts in all future capital projects. The Working

Working Group Memo – October 6, 2023

Group requests that it be approved to continue to support future projects (e.g., Field 2) and to annually assess the potential for public health or environmental issues with future, proposed projects. We anticipate that the specifications for the next turf field resurfacing project can be strengthened so that the result is ever greater functional performance and reduced public health and environmental impacts.

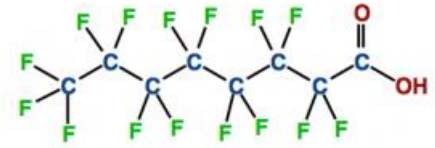
The Sustainability & Resilience Office has been working on an Environmental Procurement Policy that would help to guide all departments in Town to integrate these types of assessments into all material procurements so that they are considered at the start of the process and improved on an ongoing basis. The Working Group encourages the adoption of this policy so that all Town departments proactively include public health and environmental considerations when making purchasing decisions.

Working Group Members:

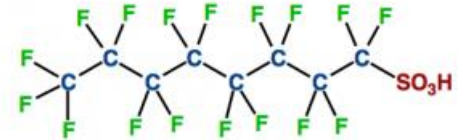
- Rick DeAngelis, Chair – Recreation Committee
- Christian Boutwell, Vice Chair – Recreation Committee
- Lisa O'Brien, Recreation Committee
- Wendy Heiger-Bernays, Chair – Board of Health
- Cindy Arens, Chair – Sustainable Lexington Committee
- Lin Jensen, Sustainable Lexington Committee
- Rick Reibstein, Sustainable Lexington Committee
- Todd Rhodes, Sustainable Lexington Committee
- Melissa Battite, Director of Recreation and Community Programs
- Joanne Belanger, Director of Public Health
- Karen Mullins, Conservation Director
- Maggie Peard, Sustainability & Resilience Officer
- Dave Pinsonneault, Director of Public Works

What are PFAS?

- Per- and Polyfluoroalkyl Substances (EPA Definition)
- PFAS are partial to fully fluorinated, organic compounds that have been produced in the largest amounts within the United States
- PFAS are the family of synthetic chemicals that include long chains of carbon and fluorine
- Up to 5,000 different PFAS, about 2 dozen “common” PFAS can be tested for
- Have unique lipid- and water-repellent characteristics, and are used as surface-active agents in various high-temperature applications and as a coating on surfaces that contact with strong acids or bases
- Found to be Ubiquitous in the Environmental across the Globe



PFOA - perfluorooctanoic acid



PFOS - perfluorooctanesulfonic acid

Historic PFAS Uses

- Used in fire fighting and odor control foams, Aqueous Film-Forming Foam (AFFF)
- Also used in industrial and commercial products including:
 - Textiles and leather products (Gore-Tex, Polartec)
 - Metal plating
 - Stain-resistant fabric
 - Photographic industry/photolithography
 - Semi-conductors
 - Paper and packaging (fast food wrappers)
 - Coating additives (Teflon)
 - Cleaning products
 - Pesticides



PFAS of Concern are Ubiquitous in our Environment

Mass Rainwater Can Be A Source Of PFAS

Individual PFAS levels of 1.8 to 3.5 ppt.

Total PFAS up to 8.5 ppt

Other studies report up to 1,000 ppt

PFAS Background in Vermont Soils

PFAS found in every sample collected.

Urban to Rural to Forested

540 to 35,000 ppb

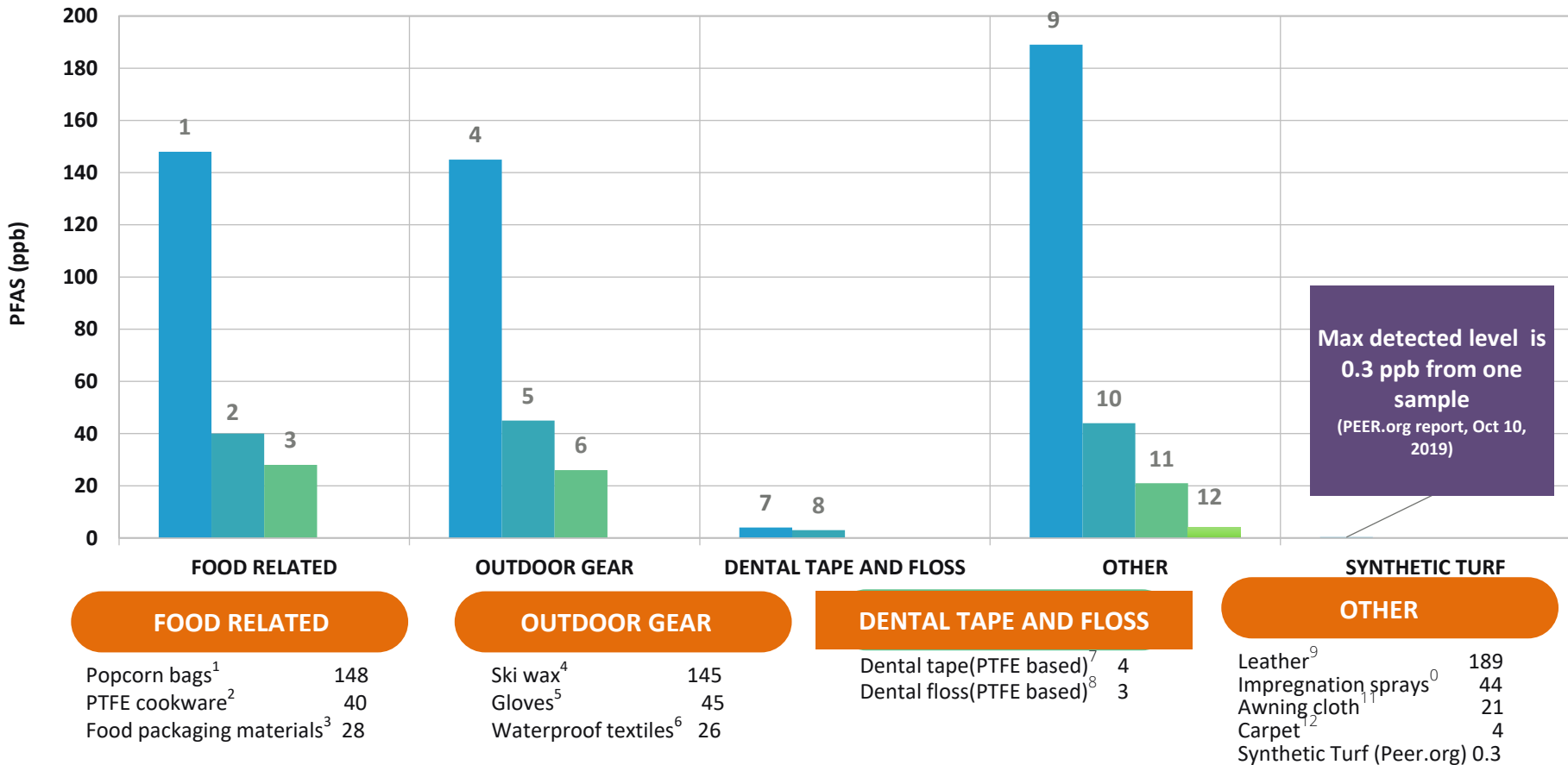
PFAS in Urine

11 ppt



Turf Contains PFAS

- PVDF-HFP
 - Processing aid
 - A large, not bioavailable PFAS
 - Used in stints, sutures, meshes
 - Not one of the Regulated Compounds by EPA or any State



RISK = CONCENTRATION & EXPOSURE

Reference Dose = 0.00002 mg/Kg body weight per day
(includes a safety factor of 300 for “interspecies” differences)

Drinking Water Limit

$$\text{RFD} * 3\text{L water per day} * 70 \text{ years} * 0.2$$

(20% of PFAS exposure from water)

4,053 gal of water with DWL concentration to increase risk of getting a disease from PFAS by 1 in 1,000,000

- 12 yrs of play on field, 3 times a week would need to drink 2 gallons of field water per practice

Recent Synthetic Turf Testing Results

Martha's Vineyard Study

The concentrations of PFAS observed by all of the analyses performed on synthetic turf components are *"...consistent with background concentrations in natural soil or at concentrations well below referenced risk-based standards..."* (TetraTech, February 26, 2021)

3rd Party review concluded *"...Based on the results presented...PFAS...have been detected in the field components at concentrations consistent with background and/or below the applicable comparison values. We agree with the report conclusion that the overall risk to human health through a direct contact exposure with the field components is de minimis."* (Horsley Whitten Group, March 1, 2021)

Portsmouth NH

This study concluded: *"Based on this evaluation, the detection of very low levels of a limited number of PFAS in the synthetic turf components does not represent a human health risk to those using the synthetic turf ballfields."* (TRC, June 7, 2022)

Based upon the information we have reviewed to date, the trace concentrations of PFAS identified in synthetic turf components which we have tested or reviewed pose No Significant Health Risk to field users or the environment.

OUR SPECIFICATIONS

To support a condition of No Significant Health Risk related to PFAS, our specifications for synthetic turf products are updated frequently to stay current with the Best Available Technology and PFAS science and require:

- 1) Certification from manufacturer that each component meets the current California Prop 65 and European REACH standards.
- 2) Each component to be installed (same batch as will be placed at our project) must be tested for the presence of PFAS. The testing results must be provided under notarized letter for review prior to approval for installation and indicate the following:
 - a. all products provided for incorporation into the synthetic turf system do not contain PFAS as quantified by EPA Method 533 Modified, EPA Method 537 Modified with isotope dilution, DoD QSM 5.4 Table B-15 or Engineer approved equivalent. The PFAS testing method utilized must report at least 29 PFAS compounds including the PFAS regulated by the STATE, and on the most current European Union REACH and California Proposition 65 compound lists.